VOL. 29 NO. 2 MARCH-APRIL, 1951

THE EXPLOSIVES ENGINEER

REG. U.S. PAT. OFF.

Forerunner of Progress in Mining, Quarrying, Construction

LESTER CUSHING ROGERS—*a biography* 36

LESTER CUSHING ROGERS—*a portrait* 37

Editorial 38

Mt. Morris Dam on New York's Genesee River 39
By CARL P. DINTRUFF

Blasting Vibrations' Effects (Part III) 42
By L. DON LEET

Stripping and Quarrying Limestone in Poland Township, Ohio 45
By R. S. SIEGRIST

Pioneering the East 47

Tales of a Gold Miner in Nicaragua 51
By C. CARLETON SEMPLE

News Notes 60

Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

Five prominent contractors, in a joint venture, are building a dam across the Genesee River at Mt. Morris, Livingston County, New York, to cost approximately $20,000,000. Rising above the stream bed with 246-ft.-high monoliths of concrete notched into the rocky banks of the river, the dam will be the fourth largest structure of its kind east of the Mississippi River.

Upon completion, the dam is expected to eliminate the possibility of floods in the Genesee countryside. A reservoir will be created which, at full pool, will extend 17 miles to Lower Portage Falls in Letchworth Park. The impounded waters will be confined within the steep-sided banks of the gorge, ¼ to ¾ of a mile in width.

A summary of the construction activities is presented by Carl P. Dintruff, beginning on page 39.

**

In Part III of the article "Blasting Vibrations' Effects," Dr. L. Don Leet writes of fantastic claims by property owners, based on theoretical assumptions. One such claim was for $16,000 damages to a dwelling nearly two miles from a quarry, in which it was stated that 500 pounds of dynamite were fired in primary blasts and 50 pounds each in frequent secondary blasting. "It is an irrefutable fact," Dr. Leet says, "that could be proved at any time by special experiment at that location that no damage of any kind could possibly have resulted under those conditions."

For further details, please turn to page 42.

**

A 70-ft.-high bank of earth, sandstone, shale, coal, fire clay, and more shale is blasted and stripped by The Carbon Limestone Company to recover a 21½-ft. seam of Vanport limestone in its quarry at Poland Township, Ohio. Bucyrus-Monighan draglines are employed to excavate and cast the blasted overburden onto a spoil bank. The limestone is recovered by firing individual blasts of 150 holes loaded with Gelamite* 1 and Hercomite* 7A, on a loading ratio of 1 lb. of dynamite to 3.4 tons of limestone in the solid.

A description of operating practices, by R. S. Siegrist, will be found on page 45.

**

The idea of pioneering usually turns our thoughts to the West. We are apt to think of the East as having been fully developed for a long time, but changes in civilized man's activities have been continuous. These are taking place more rapidly today than ever before. The point we make is proof that we are still rearranging nature in the East.

The contribution made by industrial explosives, so conspicuous in the later stages of pioneering in the West, is no less solid, if less spectacular, in the day-to-day rebuilding of the East. Please turn to page 47.

**

In the fourth part of the article "Tales of a Gold Miner in Nicaragua," C. Carleton Semple describes the types of houses built for staff employes at Matagalpa, the varied vegetable and fruit menu made possible by excellent plantings, and the training of native girls for house servants.

The article begins on page 51.

*REG. U.S. PAT. OFF.

EDITORIAL STAFF: JOSEPH I. HORTY, *Managing Editor*; ELIZABETH M. JOYCE, *Assistant Editor*; GERTRUDE A. DONNELLY, *Assistant Editor*; EDWARD L. GRANT, *Art Editor*; FRANK J. CANOVA, *Production Manager*; CHARLES E. RABENOLD, *Advertising Manager*; THEODORE MARVIN, *Director*; MONTGOMERY R. BUDD, *Associate Director*.

SUBSCRIPTION RATES: *United States and Canada*—One Year, $1.50; Single Copies, $.30. *Limited Subscriptions Only to Other Countries*—One Year, $2.50; Single Copies, $.50.

THE EXPLOSIVES ENGINEER, 913 DELAWARE TRUST BUILDING, WILMINGTON, DELAWARE. PRINTED IN UNITED STATES OF AMERICA. COPYRIGHT 1951, by HERCULES POWDER COMPANY.

Sensational

Ingersoll-Rand

MOBIL-AIR

AIR POWER

600

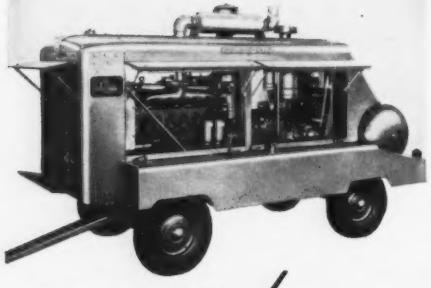
GYRO-FLOW

new 600-cfm PORTABLE COMPRESSOR

using a new advanced-design Rotary Compressor

Years ahead of any other large capacity portable

- **Amazing new GYRO-FLOW compressor . . . two-stage, oil-cooled rotary type without valves . . . without pistons, rings or rods . . . without clutch.**
- **Never gets hot . . . discharge temperatures less than 200°F under normal operating conditions.**
- **Matched to powerful, nationally-known General Motors diesel engine . . . takes full advantage of modern speeds.**
- **I-R AIR-GLIDE Capacity Control . . . the only automatic, step-less regulator that controls the air output smoothly over the full range from 0 to 100% capacity . . . all within a 10-pound pressure range.**
- **Weighs only 9500 pounds ready to run . . . as much as 20% less than other big-capacity portables.**
- **Gets maximum work out of two of the most powerful wagon drills . . . delivers full 600 cfm at 100 psi pressure.**



Weighs only 9500 lbs ready to run

by **Ingersoll-Rand**

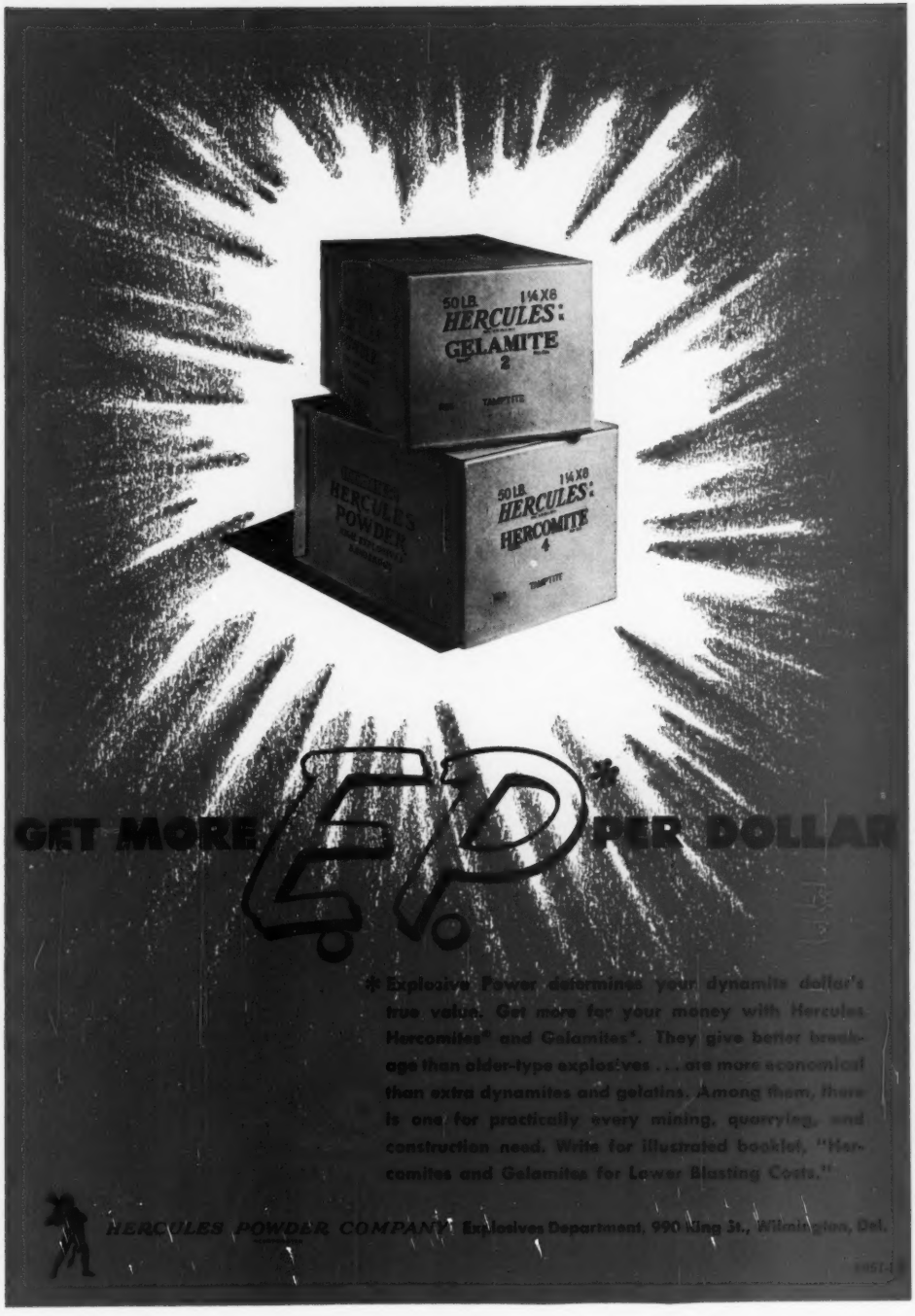
11 BROADWAY, NEW YORK 4, N. Y.

595-2

The portable compressor builder that many times before has set new standards

- **First Two-Stage Air-Cooled Portable Compressor**
- **First 500-cfm Portable that was really portable**
- **First Automatic Speed-Control of Capacity**
- **First and only MOBIL-AIR.**

Write or call your nearest Ingersoll-Rand representative for the full story.


50 LB. 1¼X8
HERCULES
GELAMITE
2
50 LB. 1¼X8
HERCULES
HERCOMITE
4
GET MORE E.D.* PER DOLLAR
* Explosive Power determines your dynamite dollar's true value. Get more for your money with Hercules Hercomites® and Gelamites®. They give better breakage than older-type explosives . . . are more economical than extra dynamites and gelatins. Among them, there is one for practically every mining, quarrying, and construction need. Write for illustrated booklet, "Hercomites and Gelamites for Lower Blasting Costs."
HERCULES POWDER COMPANY Explosives Department, 990 King St., Wilmington, Del.

Lester Cushing Rogers

PRESIDENT

BATES & ROGERS CONSTRUCTION CORPORATION

A Biography

LESTER CUSHING ROGERS, president, Bates & Rogers Construction Corporation, Chicago, is a third-generation contractor: his grandfather built the first lighthouse in Milwaukee Harbor; his father, whose biography appeared in this publication in December, 1929, was an organizer and president of Bates & Rogers Construction Company; he succeeded his father to the presidency of the company. This presentation of his biography coincides with the celebration of the 50th anniversary of the founding of the company.

Lester was born in Elgin, Kane County, Illinois, September 26, 1893, the son of Walter Alexander and Julia Margaret (Cushing) Rogers. After completing his elementary education and the local high-school course, he enrolled at the University of Wisconsin from which he was graduated in 1915, with a B.S. degree in civil engineering. He is one of seventeen in the Rogers family group to have been graduated from the University of Wisconsin, including his father and mother, three uncles, four brothers, a sister, his wife, two of his daughters, two sisters-in-law, and a son-in-law.

During the summer vacation months of 1910 through 1914, he worked for Bates & Rogers as a water boy, laborer, carpenter, blacksmith's helper, derrick operator, and timekeeper on its far-flung construction projects. Following his graduation from college, he became a full-time employe and was assigned to work as a civil engineer with the concrete-lining crew on the Connaught tunnel job in Canada. A year and a half later, he was transferred to Cleveland as assistant superintendent and engineer on the construction of subway approaches to the Detroit-Superior bridge.

In January, 1918, Lester enlisted in the Army and was sent to Third Officers Training Camp, Camp Grant, Illinois. At the end of the training period, he was commissioned a second lieutenant and went overseas in May, 1918. In France, he was assigned to further training in a French heavy-artillery school at Saumur and in an anti-aircraft school near Paris. Sent to the front on active duty with an anti-aircraft battery, he was returned, within a few months, to the anti-aircraft school as an instructor, continuing in that capacity until early 1919, when he was mustered out of the Army.

In 1923, he was moved to Cleveland as district manager of Bates & Rogers operations in eastern states. In 1934, he was made a vice president and director, and, one year later, was transferred to its main office in Chicago. In 1937, the company name was changed to Bates & Rogers Construction Corporation, and Lester was elected president.

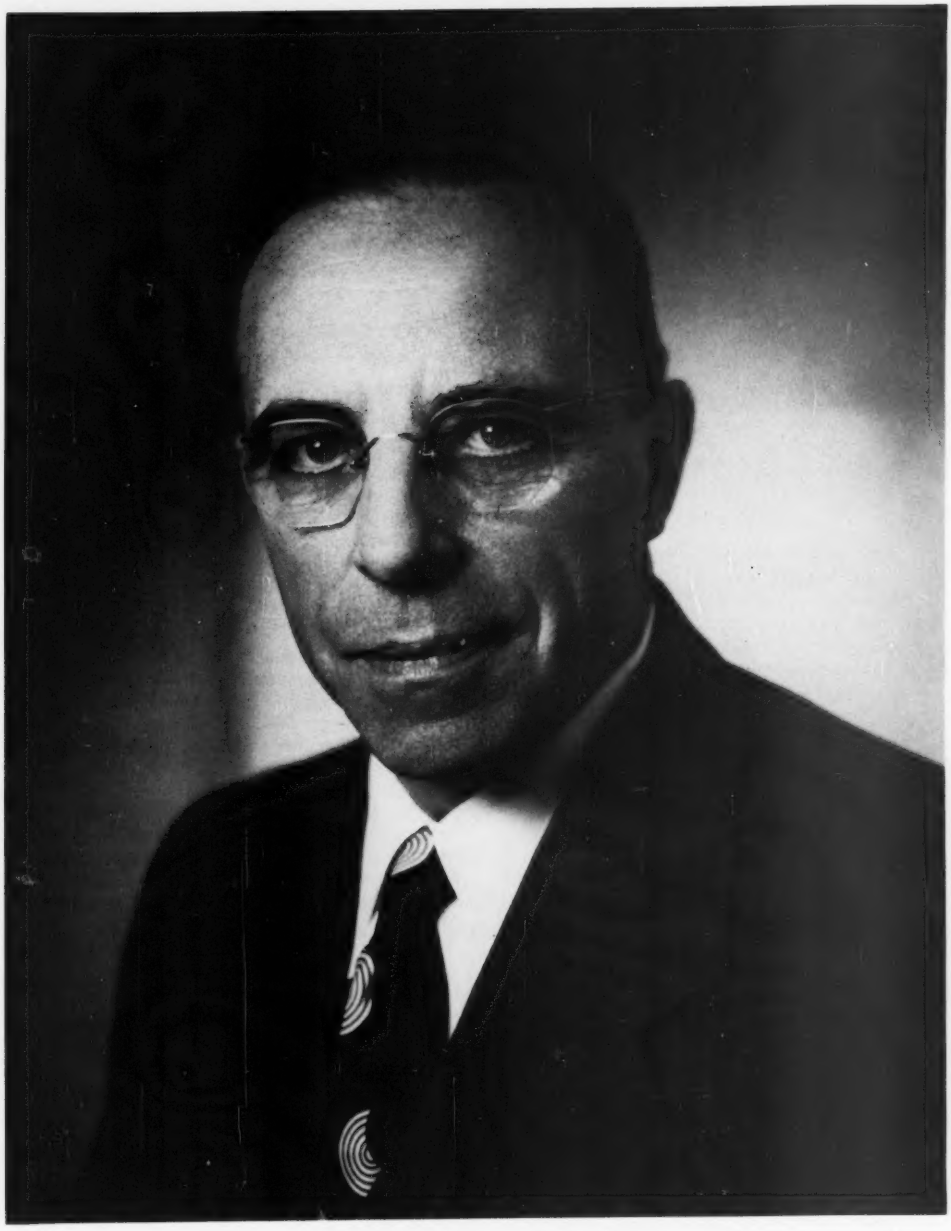
Since then, the corporation has been awarded contracts throughout the North American continent to construct diversified projects—tunnels, dams, railroads, bridges, foundations, electric generating plants, and public works of various kinds. During World War II, it built shell-loading plants, tank-landing craft, floating steel drydocks, permanent bridges on more than 1,000 miles of the Alaskan Highway, and dismantled, reconditioned, and re-erected two large blast-furnace units.

At present, major projects under construction include a 3,300-ft. double-tracked railroad tunnel, a 3,000-ft. water tunnel, several bridges, railroad yards, and electric generating plants. Also, it is participating in joint ventures in constructing large dams, a sewer tunnel, and military defense projects in North Africa.

For many years, Lester Rogers has been a director of the Associated General Contractors of America. At present, he is chairman of its Labor Relations Committee. He holds memberships in the American Society of Civil Engineers and the Western Society of Engineers. He is one of two management representatives appointed by the State Department to the last two biennial meetings of the Building, Civil Engineering, and Public Works Committee of the International Labor Organization. He has been a member of the Village Council of Winnetka, Illinois, since 1947, and now serves as its president. He is vice chairman of the Board of Trustees of George Williams College and of the Congregational Union, both in Chicago; a trustee of Chicago's Y.W.C.A. and of the Y.M.C.A. at the University of Wisconsin. He is a member of Indian Hill Club of Winnetka, Union League of Chicago, and Tau Beta Pi, an honorary engineering fraternity.

Lester Cushing Rogers married Lucile Pritchard, April 17, 1917, in Aurora, Illinois. They have four children: Nancy, Lucile (Mrs. F. H. Orbison), Barbara Ellen (Mrs. H. W. Stinson), and Lester Cushing Rogers, Jr. The family home is at 340 Woodland Avenue, Winnetka, Illinois.

Like other leaders in industry and the professions, Lester Rogers interrupts a heavy work schedule for relaxation with his family and friends, with emphasis on fishing and playing golf.



LESTER CUSHING ROGERS

Editorial

Coal in High Gear

Since January 1, 1951, the combined output of 6,000 independent coal-producing companies in 30 states averaged more than 10 million tons a week. For the first three months of this year, total production is estimated at approximately 135 million tons. In realizing this tonnage, the industry has kept pace with the national defense program schedules.

The Bituminous Coal Institute reports that "current coal production is at approximately the same level with that of the war years, but it is far from the industry's maximum potential. Bituminous coal companies produced 630 million tons in 1947 and can do so again, if the need should arise."

No-Accident Records

No-accident records are the result of purposeful, determined, continued, and coordinated effort on the part of every employe in an organization, from the top to the bottom.

When public announcement is made that a large mine or quarry has been operated for 12 consecutive months without a disabling injury, the question is often asked: "How do they do it?"

The usual assumption is that such a perfect safety record was made by utilizing special methods, skills, or knowledge. Investigation almost always leads to the same discovery—safety is an operating problem. It cannot be achieved by any prescribed methods or techniques, or at any price.

The employment of safety engineers, changes in methods, mechanical safeguards, and accident-prevention campaigns, all accomplish wonders. But, until every operating supervisor and every workman is persuaded that accident prevention is his personal responsibility, improvement will be limited. When every official and every employe accepts this responsibility, safety records are made.

Construction Job Management

The small amount of published information directly pertinent to construction job organization and management is difficult and time-consuming to locate in the mass of management literature, most of which deals with the manufacturing industries.

To make such papers easily and quickly available, The Engineering Societies Library has compiled an annotated bibliography of 52 selected references to books and periodical articles that deal with construction job planning, work scheduling, costs, organization, material-requirement charts, material-delivery scheduling, material and equipment control, job progress records, time studies, and procedures on various kinds of contracting projects such as tunnel, dam and highway construction, small- and large-scale housing, office and factory building.

The references, known as *Bibliography No. 8*, may be purchased for $2.00 from The Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

The 1951 Coal Convention

The 1951 Coal Convention and Exposition of the American Mining Congress will be held in the Public Auditorium, Cleveland, Ohio, May 14 through 17. A 44-man program committee, headed by C. J. Potter, president of Rochester & Pittsburgh Coal Company, has completed plans for general sessions, special meetings, and group forums for the examination and discussion of new methods and equipment to increase efficiency in the mining and preparation of coal, progress in mine safety, personnel training, labor relations, and the advances made in promoting greater coal utilization.

To date, 239 nationally known manufacturers have reserved space in the Exposition, with complete displays of their products for boosting production and preparation, improving quality, and cutting costs. They have been assigned space in five exhibit halls plus the huge main floor of the arena for the showing of the greatest galaxy of coal-mining machinery, equipment, and materials ever assembled in one place. Each display will be manned by technical experts who will welcome the opportunity to discuss the application of their products in mechanized mining operations.

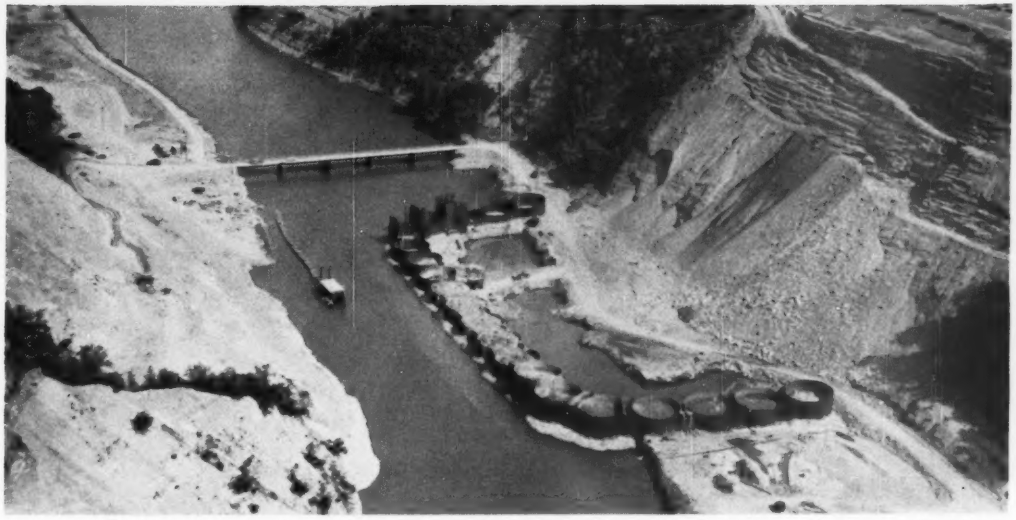
Fred Waring and his company of 58 artists will entertain the delegates in the auditorium's Music Hall on Wednesday evening, May 16. This is the only evening event scheduled during the four-day meeting.

A record attendance at the convention is indicated by the unusually large number of registrations already received. If you are planning to attend and have not made arrangements for hotel reservations, communicate with the Cleveland Housing Bureau, 511 Terminal Tower, Cleveland 13, Ohio.

Don'ts

Don't purchase, possess, store, transport, handle, or use explosives except in strict accordance with organizational, local, state, and federal regulations.

Don't store explosives anywhere except in a magazine which is clean, dry, well ventilated, properly located, substantially constructed, and securely locked.



THE PROJECT SITE: The contractor started work on March 22, 1948, with crews clearing the site. Walls of the gorge were stripped of creep mantle and rock. A 20-cell cofferdam was constructed on the south side of the river to provide a work area.

MT. MORRIS DAM
ON NEW YORK'S GENESEE RIVER

Five prominent contractors are building a $20,000,000 structure in the Grand Canyon of the East, to impound the runoff from a watershed of 1,077 square miles

CARL P. DINTRUFF*

THE construction of Mt. Morris Dam on the Genesee River at Mt. Morris, Livingston County, New York, is another example of man's ingenuity and skill in overcoming nature's primitive forces and converting them to his will and service. Rising above the stream bed with 246-ft.-high monoliths of concrete notched into the high, rocky banks of the river, the dam will be the fourth largest structure of its kind east of the Mississippi River.

The Genesee River rises in the Allegany Mountains in Potter County, Pennsylvania, flows generally north through west-central New York State for about 157 river miles, and empties into Lake Ontario at Rochester. Mt. Morris Dam, when completed, will impound the runoff from a watershed of 1,077 square miles. Upstream from the dam site, the watershed is mildly mountainous; downstream, it is generally rolling. A reservoir will be created which, at full pool, will extend 17 miles to Lower Portage Falls in Letchworth Park, New York. The impounded waters will be confined within the natural, steep-sided banks of the gorge that varies from ¼ to ¾ of a mile in width.

*Hercules Powder Company, Rochester, New York.

The completed dam is expected to eliminate the possibility of floods in the Genesee countryside, which have plagued the region since 1800. The most destructive flood was experienced in 1865. At the crest of that flood, the river discharged 24 million gallons of water a minute, three times the volume of water that is hurtled over the American side of Niagara Falls. Extensive damage was done to railroads, highways, homes, and business establishments in Rochester and to fertile farm lands south of the city. Records show that there have been damaging floods in the Genesee Valley almost every year since. Damage was done not only in the flats above Rochester, but also within the city itself.

Proposed in 1889

Construction of a dam on the Genesee River was first proposed by the State of New York in 1889, for the purpose of controlling the water supply for the Erie Canal. The project never materialized. From 1923 to 1926, the Rochester Gas and Electric Corporation made surveys and acquired lands in the Mt. Morris reservoir area

ONE YEAR LATER: An airplane view of the job site on April 7, 1949, reveals the progress made after a year of diversified construction activities. The first bucket of concrete for the foundation of the dam was poured April 27, 1949.

BLASTING SHALE: A 16-ft. shale formation in the foundation area had to be blasted a few feet at a time to avoid disturbing the walls of the gorge.

for the construction of a dam and power plant. These plans were subsequently abandoned. In 1936, the Congress of the United States authorized a survey to be made and a report submitted on the feasibility of controlling the Genesee River. In May, 1941, the United States District Engineer submitted a report to the Divisional Engineer and to the Board of Engineers for Rivers and Harbors.

In 1943, the realization of the dream of a dam on the river began to materialize with the driving of three exploratory tunnels into each side of the high river banks. The tunnels were driven for the purpose of examining the rock structure of the gorge and determining the depth of the proposed curtain wall. The bores extended horizontally from 100 to 150 ft. into the walls of the gorge. By December 1, 1947, construction plans and specifications were completed, and invitations were issued to contractors to bid publicly for the job of building the dam.

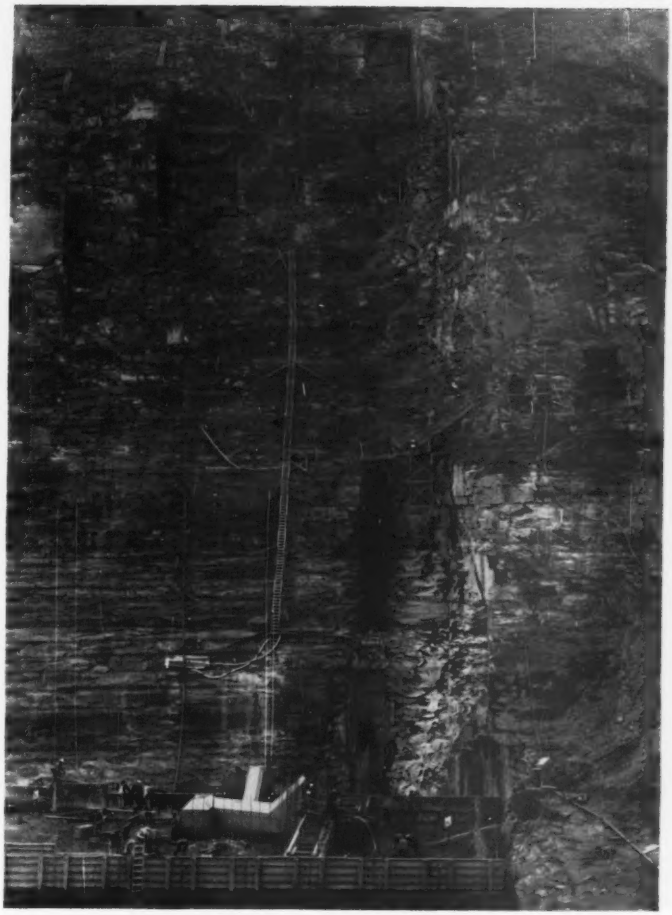
On January 23, 1948, a contract for the construction of Mt. Morris Dam was awarded to a newly organized company called Mt. Morris Dam Builders, comprising five nationally known contractors. The five companies in this joint venture included J. C. Maguire, Los Angeles, California; The Arundel Corporation, Baltimore, Maryland; L. E. Dixon Company, San Gabriel, California; Shofner, Gordon and Hinman, Los Angeles, California; and The Hunkin-Conkey Construction Company, Cleveland, Ohio. The successful bid was $20,204,200.00.

Some of the principal items in the contract specifications include:

Common excavation. 470,000 cu. yds.
Rock excavation..... 200,000 cu. yds.
Mass concrete in dam 690,000 cu. yds.
Concrete in appurtenant works ..... 77,000 cu. yds.
Placing of 3,000,000 lbs. of reinforcing steel.
Installation of nine sets of conduit gates.

The dam is of the concrete-gravity type with a maximum height above the stream bed of 216 ft. At its top, the total length is 1,003 ft., with a total width of 20 ft. The spillway will have an overall length of 550 ft. and a discharge of 20,000 cu. ft. a second, with the pool at elevation 765 ft. For normal river regulation and to empty the reservoir after flood periods, nine 5 by 7-ft. conduits are to be provided. Each conduit will be controlled by two hydraulically operated slide gates, one to be reserved for emergency purposes. Although the Mt. Morris reservoir is to be used for flood control only, provisions for penstocks have been made in the left abutment, to provide for any future plan for the development of the water resources of the Genesee River Basin. Two openings, 19-ft. 9-in. inside diameter, will be constructed through the left abutment to provide for the future installation of 18-ft.-diameter penstocks. Eventually these openings will be plugged at their extremities with 2-ft.-thick concrete caps.

The stilling basin floor will be at elevation 560 ft. The basin floor will be 5 ft. thick, with a width of 470 ft. and a length of 240 ft. Two complete rows of baffles and a stepped-up end sill will be constructed. Concrete training walls at each side of the basin are to be constructed for the protection of the valley walls against high velocities.



CURTAIN WALL: Rock was blasted and excavated from the right abutment, using stoping methods, to provide for a 6-ft.-wide curtain wall.

Construction Started in 1948

Work was started on March 22, 1948, with crews clearing the site. The walls of the gorge were stripped to remove creep mantle and weathered rock. A cofferdam of 20 cells was constructed on the south side of the river bed to provide a work area. It was necessary to excavate about 25 ft. of gravel and shale to provide a suitable foundation for the dam at elevation 541 ft. Approximately 16 ft. of the shale was removed by blasting a few feet at a time. Hercules Gelamite* 2 and 40% Gelatin Extra dynamite in 1¼ by 8-in. cartridges were used in removing this rock. To avoid disturbing the walls of the gorge, the work was done in such easy stages that no set drilling and shooting pattern could be established. Some blasts consisted of only a few holes; others of as many as 200 holes. The excavation of the 6-ft.-wide curtain wall, or cutoff wall, was started by driving a tunnel about 50 ft. in length into the south abutment at elevation 540.8 ft., and into the north abutment at elevation 543.2 ft. As the curtain wall excavation progressed up-

(Continued on page 57)

*Reg. U. S. Pat. Off.

Blasting Vibrations' Effects

Practically everything that moves generates elastic vibrations, physically the same as those generated by blasting with explosives

L. DON LEET*

PART III

THE U. S. Bureau of Mines conducted an extensive series of tests to determine the amount of vibration necessary to crack plaster, which is normally the weakest structural material in a building. The results were reported in detail in their Bulletin 442 published in 1942.

The largest motions produced in buildings by earthborne elastic waves from blasting do not exceed 10 cycles per second and are often lower in frequency. Within this range, the Bureau of Mines, using machine-induced vibrations applied continuously (because they failed to find a single case in which commercial blasting produced damaging vibrations), determined experimentally that displacements between 100 and 250 thousandths of an inch (.100 - .250 in.) were required to crack or produce fall in plaster, with a few isolated exceptions of minor cracks from motion as small as 50 thousandths of an inch (.050 in.). In their tests in buildings where vibrations caused by blasting were measured, the largest vibrations were 1/10 of a magnitude necessary to endanger plaster, and the greatest number was 1/100 or less.

In 1949, F. J. Crandell, of Liberty Mutual Insurance Co., published the results of extensive tests to determine damage criteria. (*Journal, Boston Society Civil Engineers*, p. 222, April, 1949.) He applied the term Energy Ratio, or E. R., to the square of the acceleration divided by the square of the frequency for the earth waves from blasting. In other words,

$$\text{E. R.} = \frac{a^2}{f^2}$$

This ratio is directly proportional to the kinetic energy of the vibrations, or their capacity for doing work.

Crandell found that when the E. R. in the ground reaches a value of 3, old buildings pre-stressed by settlement and shrinkage or expansion of frame members owing to moisture content are likely to be damaged. When the E. R. in the ground becomes 6, damage will occur to residential types of buildings or brickwall-bearing structures. As a result, an E. R. of less than 3 characterizes safe vibration; between 3 and 6 is a zone of caution; and greater than 6 represents danger. The figure of 50 thousandths of an inch (.050 in.) displacement at 10 cycles per second given here from the investigations of the U. S. Bureau of Mines produces an E. R. just short of 3 and agrees perfectly with the results of Crandell.

An overwhelming majority of observations in houses in the vicinity of blasting shows displacements from vibrations in the range of 1 to 10 thousandths of an inch (.001 - .010 in.). Vibrations of this magnitude are produced daily in the same houses by ordinary walking, slamming of doors, and in some cases by nearby traffic. An example of this is shown in Figure 10. There, the vibrations from a 12-hole short-period delay shot of 9,800 lbs. at 2,440 ft., recorded in the living room of a dwelling, are shown in the top record. In the bottom record are displacements caused by the observer flexing his knees on the same floor to simulate the effect of walking.

In contrast to these are natural strains produced by changes in materials from which a house is fabricated. Shrinkage or expansion of wooden members, for example, frequently causes changes of ½ to 1 in., that is, 500 to 1,000-thousandths, as moisture content changes from season to season. Such displacements in house panels readily produce plaster cracks.

In fact, builders and many laymen are aware that it is a rare situation indeed to find plaster in dwelling structures entirely free from cracks pro-

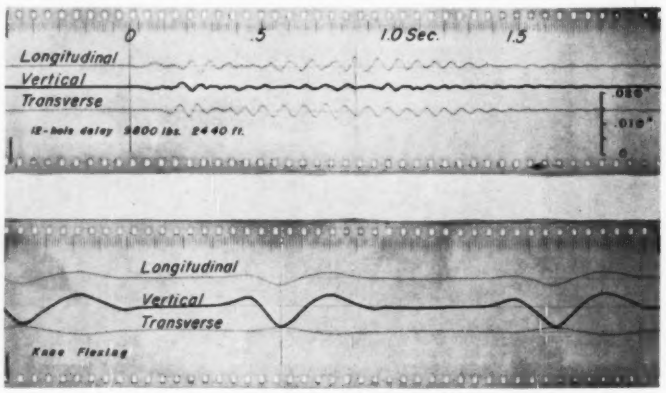


FIGURE 10: Vibrations from a blast (top record) compared with the effects of walking on the same floor in a dwelling house living room (bottom record).

*Professor of Geology; Seismologist in Charge, Seismograph Station, Harvard University, Cambridge, Massachusetts.

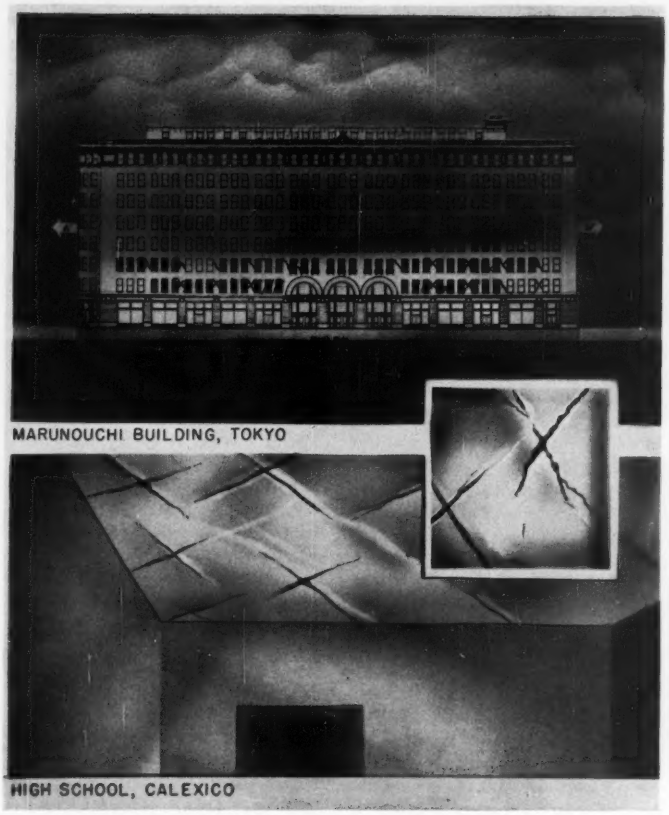


FIGURE 11: A pattern of cracking produced by damaging earth vibrations.

duced by natural causes, without any reference to vibration from external sources. The Architects' Small House Service Bureau of the United States, Inc., has published a list of 40 reasons why walls and ceilings crack. (*The Small Home*, Vol. 4, No. 8, 1925.) They are tabulated below:

1. Building a house on a fill.
2. Failure to make the footings wide enough.
3. Failure to carry the footings below the frost line.
4. Width of footings not made proportional to the loads they carry.
5. The posts in the basement not provided with separate footings.
6. Failure to provide a base raised above the basement floor line for the setting of wooden posts.
7. Not enough cement used in the concrete.
8. Dirty sand or gravel used in the concrete.
9. Failure to protect beams and sills from rotting through dampness.
10. Setting floor joists one end on masonry and the other on wood.
11. Wooden beams used to support masonry over openings.
12. Mortar, plaster, or concrete work allowed to freeze before setting.
13. Braces omitted in wooden walls.
14. Sheathing omitted in wooden walls (except in "back-plastered" construction).
15. Drainage water from roof not carried away from the foundations.
16. Floor joists too light.
17. Supporting posts too small.
18. Cross beams too light.
19. Subflooring omitted.
20. Wooden walls not framed so as to equalize shrinkage.
21. Poor materials used in plaster.
22. Plaster applied too thin.
23. Lath placed too close together.
24. Lath run behind studs at corners.
25. Metal reinforcement omitted in plaster at corners.
26. Metal reinforcement omitted where wooden walls join masonry.
27. Metal lath omitted on wide expanses of ceiling.
28. Plaster applied directly on masonry at chimney stack.
29. Plaster applied on lath that are too dry.
30. Too much cement in the stucco.
31. Stucco not kept wet until set.
32. Subsoil drainage not carried away from walls.
33. First coat of plaster not properly keyed to backing.
34. Floor joists placed too far apart.
35. Wood beams spanned too long between posts.
36. Failure to use double joists under unsupported partitions.
37. Too few nails used.
38. Rafters too light or too far apart.
39. Failure to erect trusses over wide wooden openings.
40. Floor joists not bridged.

The general pattern of cracking in plaster or masonry will usually give a clue to the forces which produced the cracking. To find cases where this was clearly done by earthborne vibrations which shook the structure, it is necessary to go to places which have been subjected to earthquake vibrations of damaging magnitude. There, it is found that true vibration cracks appear in a unique pattern. Since they are caused by to-and-fro motions, if displacement in one direction is sufficient to cause failure, it is generally followed by displacement in the opposite direction also capable of causing fracture. The result is a crisscross or "X" pattern of sets of cracks aligned at nearly right angles to each other and at angles approximating 45 degrees to the walls of the building.

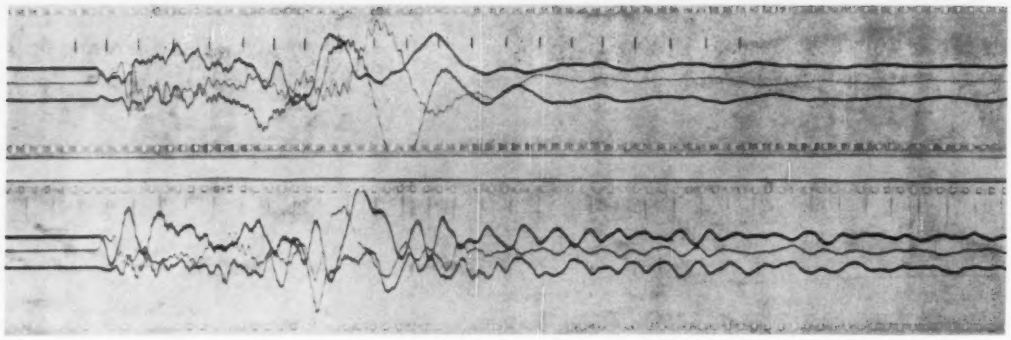


FIGURE 12: Vibrations from a tunnel, or coyote, blast of 1,362,985 lbs. of dynamite at South Holston, Tennessee, February 5, 1949. Top record at 8,000 ft.; bottom record at 11,500 ft.

The top half of Figure 11, based on a photograph, shows this effect on the Marunouchi Building, opposite Tokyo Station, Japan, after the earthquake of Thursday, April 26, 1922.

The bottom half of Figure 11 is a sketch, also based on a photograph, showing the result of this earthquake in a hallway of the Calexico, California, high school after the earthquake of 1927.

At a given point, both branches of the "X" may not be fully developed, but its two directions dominate the system of cracks, and the pattern is unique. In clear contrast to this is the single directional character of settlement cracks and the random pattern produced in plaster by most of the 40 causes listed. Naturally, many of these cross each other at 90 degrees and other angles, but that random type of intersection is not the systematic pattern referred to above.

People who observe vibrations without instruments are not reliable judges of the effects. Precise physiological tests have established that vibrations can be detected by human beings when they are no more than 1/100 of those which cause damage to structures. For example, at 10 cycles per second, a vibration of ½ of a thousandth of an inch (.0005 in.) is easily noticeable to some; 5 thousandths of an inch (.005 in.) may be troublesome to more persons; 12 thousandths of an inch (.012 in.) may seem severe to many persons; but 50 thousandths of an inch (.050 in.) displacement is necessary to reach the zone of caution for structures. These general ratios are maintained at other frequencies.

The fact that vibrations resulting from the detonation of dynamite are perceptible in a building, especially if they are accompanied by enough movement of the air to rattle a window, or if dishes in the kitchen rattle, sometimes causes people to jump to the conclusion that there is something out of the ordinary and particularly lethal about them. Actually, the effect on the dishes is no different from when they rattle from somebody's walking across the floor, or on the window than when it is shaken by a light breeze or by a person's placing his little finger against it and pressing gently. The materials of a building cannot distinguish beween the vibrations which shake them when a door is slammed and any of the same magnitude from distant blasting. The effects of all are governed by the same laws.

Some truly fantastic claims are based on purely theoretical assumptions by property owners who hear blasting and then suddenly become aware of plaster or concrete cracks which had been there all along, but which had not been noticed before. One such was a claim for $16,000 damage to a dwelling nearly 2 miles from a quarry, in which it was stated in impressive tones that 500 lbs. of dynamite were fired in primary shots and 50 lbs. each in frequent secondary shooting. It is an irrefutable scientific fact that could be proved at any time by special experiment at that location that no damage of any kind could possibly have resulted under those conditions. Yet, long, solemn, legal action resulted, in which scientific testimony was characterized as theoretical and academic, while a lay jury was in a position to accept as "fact" any of the finely spun, imaginative, but thoroughly unsound, plaintiff's guesses presumably connecting the blasting with the alleged condition of the house.

Few people actually realize what extremely large amounts of explosives would be required in commercial blasting to produce the amount of vibration known to be necessary to endanger structures. Figure 12 shows two records of the ground motion from the largest quarry blast in history. It consisted of 1,362,985 lbs. loaded in nearly a mile of tunnels honeycombing a mountain top near South Holston, Tennesee and fired by TVA on February 5, 1949, to obtain broken stone for a dam. At 8,000 ft., the maximum displacement was 27 thousandths of an inch (.027 in.) and at 11,500 ft., it was 18 thousandths of an inch (.018 in.). Both of these were less, by conservative margins, than the 180 thousandths of an inch (.180 in.) necessary to endanger plaster at the frequency involved, 3 cycles per second. Concrete foundations, glass, and other materials of an office building 1,900 ft. from the shot were entirely unharmed.

(All records of Figures 3, 6, 7, 9, and 11 taken on Leet 3-component portable seismograph. Those of Figures 3 and 9 taken by the author; of Figures 6 and 7 by Ranald E. Jones; the top record of Figure 11 by Jules E. Jenkins and the author; the bottom record of Figure 11 by Jack Wiss.)

STRIPPING AND QUARRYING
LIMESTONE
In Poland Township, Ohio

A 70-ft.-high bank of earth, sandstone, shale, coal, fire clay, and more shale is blasted and stripped by The Carbon Limestone Company to recover a 21½-ft. seam of Vanport limestone

R. S. SIEGRIST*

IRON ORE was first mined in the vicinity of Youngstown, Ohio, in 1803, by Daniel Eaton. Shortly afterward, he built and operated a blast furnace, the first one north of the Ohio River and west of Pennsylvania. From that modest beginning, Youngstown has grown to be the center of the second largest iron and steel manufacturing district in the United States.

Following the discovery of iron ore, deposits of coal and limestone were found in the region, both used in the production of pig iron. As the demand for pig iron grew, the production of these minerals increased. Within a comparatively short time, the deposits of iron ore were exhausted. However, the limestone deposits have continued to be available.

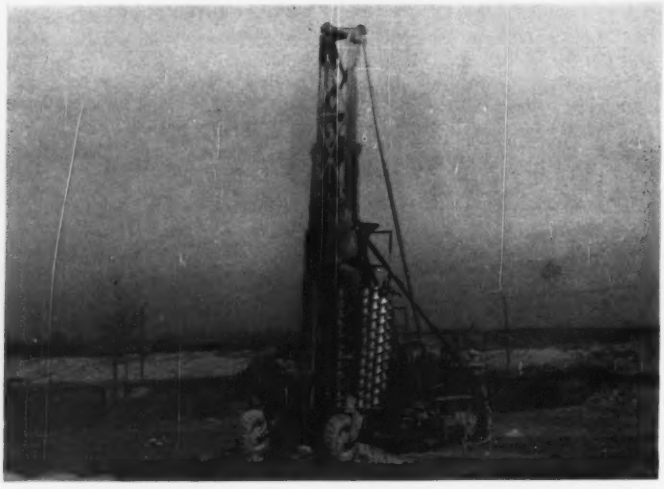
Hiram Parks was an early quarry operator in Mahoning Township, Lawrence County, Pennsylvania, producing fluxing stone for use in blast furnaces. Parks sold his property to John A. and Edith A. Logan and, within a short time, the Logans began to quarry the stone, operating as a partnership. In 1870 they dissolved the partnership and formed a company to continue the business under the name of Carbon Limestone Company. In 1881, Brier Hill Limestone Company was added to the company's holdings. Six years later, an article of local interest appeared in the Youngstown Daily Telegram, under the heading "A Mammoth Blast." The article read: "Perhaps the largest blast ever made in this section of the country occurred on Friday, November 4, at Quarry No. 1 of Carbon Limestone Company at Hilltown. One hundred and thirty-one holes, each 8 ft. deep and about 2 in. in diameter, were drilled into the rock with steam piston drills, the work requiring 13 days for completion. The holes were then filled with 50 lbs. of dynamite and 375 lbs. of black blasting powder. The mines were exploded simultaneously by electricity. The explosion was a mighty roar, heard for miles around. Twelve thousand tons of stone were replaced and avenues were made in the solid rock through which teams might be driven."

In 1894, the company was incorporated and its name was changed to The Carbon Limestone Company. The property owned comprised 2,700 acres, located about 10 miles equidistant from Youngstown, Ohio, and New Castle, Pennsylvania. The 1¾-mile-long quarry is in Poland Township, Mahoning County, Ohio, and the processing plant is in Mahoning Township, Lawrence County, Pennsylvania.

Since the beginning of its activities, operating procedures in The Carbon Limestone Company's quarry and plant have been periodically overhauled and new equipment installed,

IN THE QUARRY: This view of the quarry shows the 650B dragline operator stripping overburden in the background; a 25-ton locomotive en route to the crushing plant with a train of blasted limestone; a wagon drill crew drilling vertical holes into the limestone for blasting; and a Marion shovel at work in a bank of blasted limestone.

*Youngstown, Ohio.



LINDEN PITZ DRILL: Vertical holes, 6 in. in diameter, are drilled 33 ft. deep through clay, sandstone, and shale overburden with a tractor-mounted drill rig equipped with auger drills.

WAGON DRILLS AT WORK: A battery of Cleveland D-14 wagon drills is employed to drill vertical holes 2 in. in diameter, for primary blasting in the limestone formation.

LOWER LEVEL: A power shovel loads out blasted limestone, while a blasting crew on top of the ledge makes preparations for loading explosives into drill holes.

to keep abreast of the technical and mechanical improvements in the industry. Company policies have been formulated and administered through the years by succeeding groups of aggressive, public-spirited men. Major John A. Logan, Jr., was its first president. Today's president, Frank B. Thacher, is a director of the National Crushed Stone Association, and Vice President Philip E. Heim is the president of Agricultural Limestone Institute and a member of the executive committee of National Crushed Stone Association.

When the company added railroad ballast and concrete stone to its salable products in 1910, there still were some by-products from the original fluxing-stone business that had not been commercialized. The installation of a Williams Universal crusher and pulverizer made possible the conversion of unused by-products into agricultural limestone, for distribution to a new customer group—the farmers. In this connection, it is of interest to include a report from Pennsylvania's Experiment Station: "After 20 years (1882 to 1901) results have been obtained showing that with every product a greater total yield had been obtained from plants treated with limestone than from those treated with burned lime."

The limestone quarried is the Vanport seam in the Niagara series of the Allegheny group, Pennsylvania system. It has a uniform thickness of 21 to 22 ft., with the upper 12 to 15 ft. usually consisting of gray, highly fossiliferous limestone in which the bedding planes are rather widely separated and regular in character. A very hard formation occurs below the gray, called the blue. When blasted, it breaks into irregular fragments.

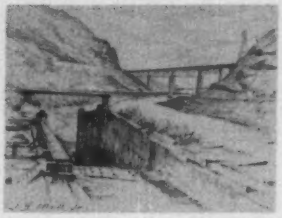
Stripping the Overburden

In stripping the overburden covering the limestone, 70 ft. of varying layers of earth, sandstone, shale, coal, fire clay, and more shale have to be removed. The first operation calls for blasting and excavating about 35 ft. of material on top of a 2-ft. seam of lower Kittaning coal. Approximately 25 holes, 6 in. in diameter, 70 to 80 ft. deep, spaced on 15-ft. centers, are drilled

(Continued on page 55)

PIONEERING THE EAST

PIONEERING is rearranging nature and superimposing man-made contrivances to suit the uses of civilization. The idea of pioneering usually turns our thoughts to the West. We are apt to think of the East, especially the highly industrialized northeastern section of our country, as having been fully developed for a long time.

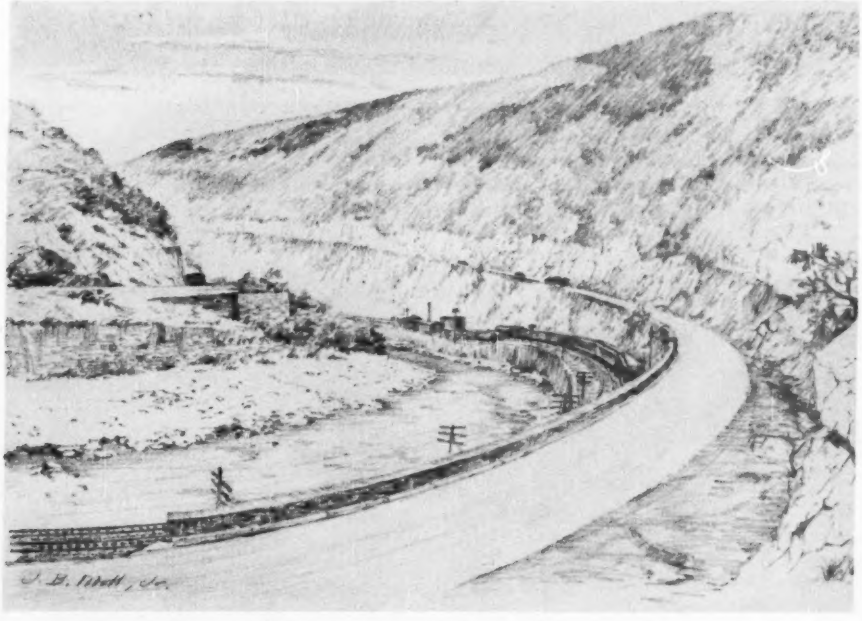


An abandoned lock on the canal at Lehigh Gap, near Mauch Chunk.

Two and a half centuries ago the Colonists set about conquering their wilderness on the Atlantic seaboard, and establishing a system of communication and transportation—the main essentials to civilization, after food and shelter. At first the chief arteries in this system were rivers and bays. Later, trails became roads of a sort, and canals supplemented natural waterways.

Had the uses of civilization remained static, our northeastern states, and others, too, might well have been fully developed long ago. But changes in the activities of civilized man have been continuous, and are taking place more rapidly today than ever before. Thus, we are still rearranging nature in the East and adding more man-made contrivances to take care of ever-increasing highway traffic, and to provide facilities for air transportation.

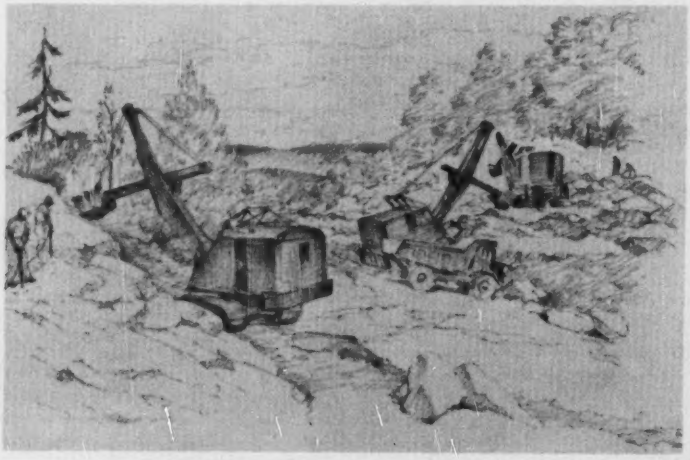
The contribution made by industrial explosives, so conspicuous in the later stages of pioneering in the West, is no less solid, if less spectacular, in the day-to-day rebuilding of the East.

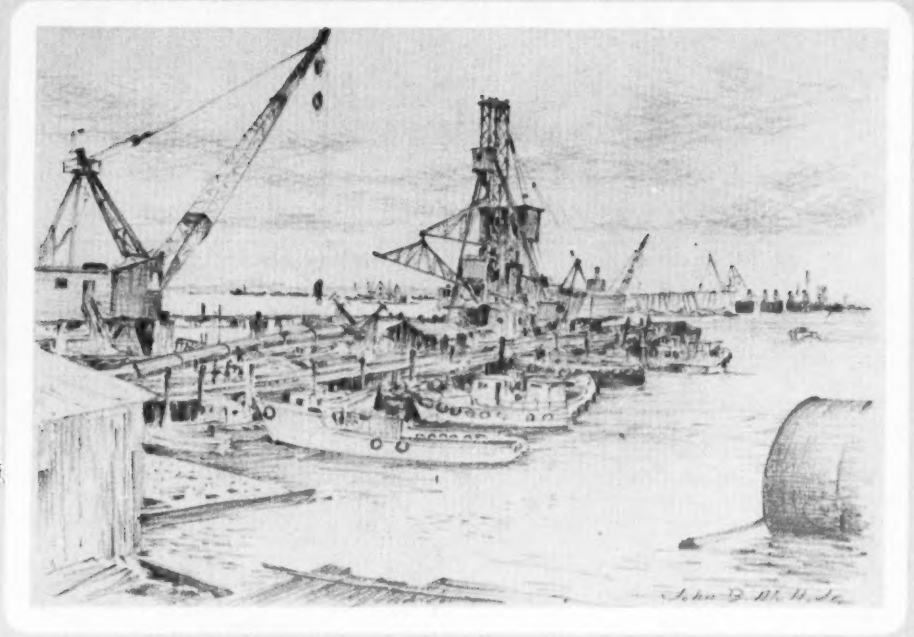


For many years it was literally true that the longest way round was the shortest way home. Early roads clung to the circuitous courses of waterways and Indian trails. Many modern transportation lines follow the old ones, as witness this highway and the railroad tracks paralleling an old canal near Mauch Chunk, Pennsylvania. But the straight line is still the shortest distance between two points, and today's highway engineers, with dynamite and improved construction equipment, can frequently follow routes that demonstrate this theorem.

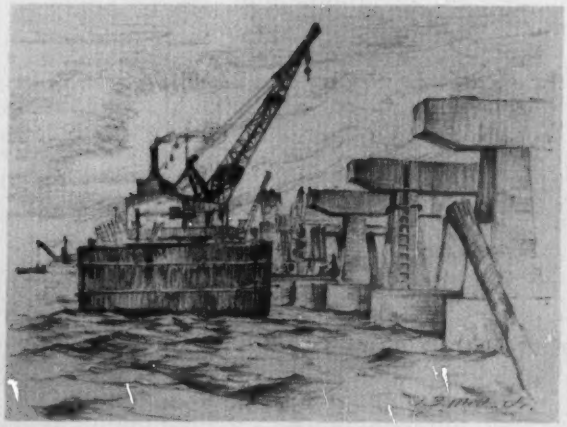
Constructing cloverleaf and overpass on the Pennsylvania turnpike from Philadelphia to Harrisburg to connect with Pittsburgh. Another link in a vast system of parkways and turnpikes which, ultimately, will accommodate high-speed through traffic from Maine to Florida, and from East to West.

Blasting a heavy rock cut on the turnpike near Morgantown, Pennsylvania.

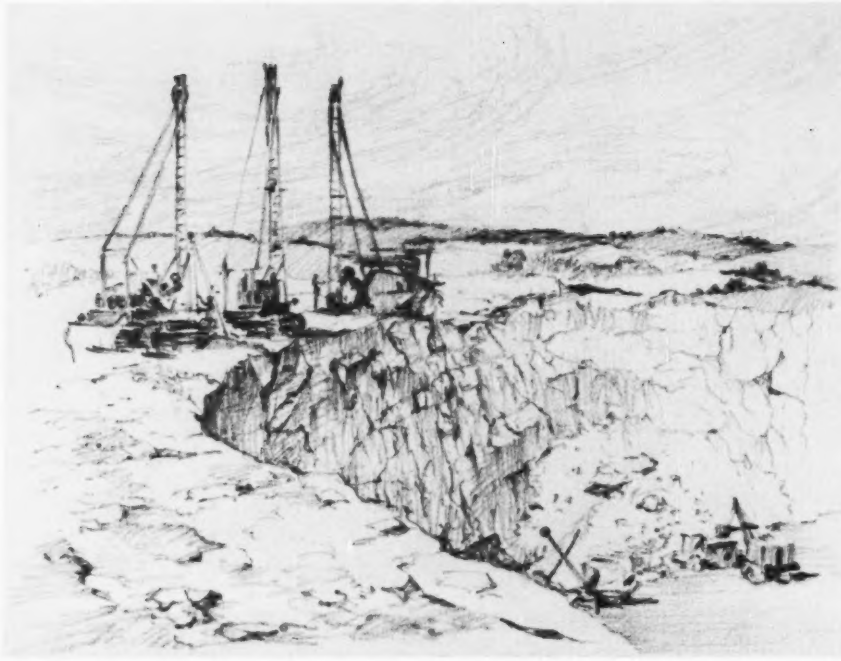




The new Chesapeake Bay Bridge connecting Stevensville on Maryland's eastern shore with Sandy Point on its western shore will speed motorists, now dependent upon slow ferries, in their movements north and south.



Pilings for the new Chesspeake Bay bridge. The great quantities of crushed stone and cement required for bridges, highways, and other construction projects are torn from our quarries with explosives.



This Pennsylvania limestone quarry near Reading is one of thousands that supply crushed stone and cement for bridges, highways, and other man-made contrivances. Explosives knock down the stone for crusher and mill, and help in the rearrangement of nature which must often precede construction.

A cement mill at Cementon, Pennsylvania.

Drawings by J. B. Mell, Jr.

TALES OF A GOLD MINER IN NICARAGUA

By C. CARLETON SEMPLE*

Some rambling recollections of mining operations under peacetime and wartime adversities

PART IV

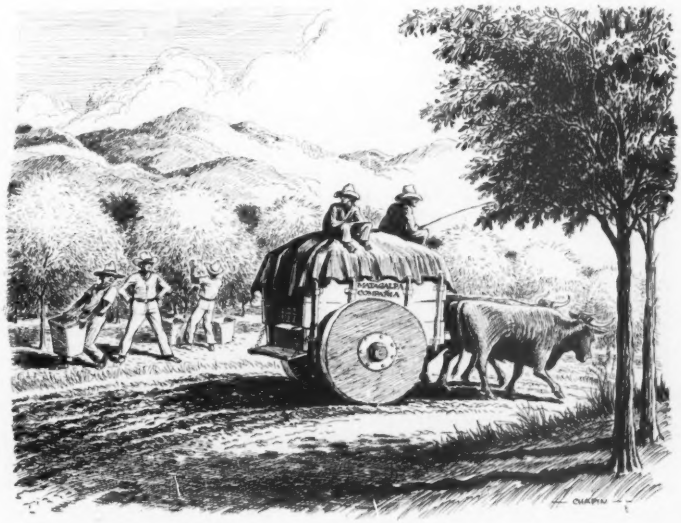
A PARALLEL vein, some 2,000 ft. north of the vein being mined, had been explored by a short crosscut and drift not very deep below the outcrop. I had continued the work by sinking a winze until the rainy season began, when the influx of water was too much for the capacity of the available pumps. We drove a long crosscut from the zero level, continuing the haulage adit to this parallel vein, and then a raise was cut to the bottom of the winze, a total distance of some 500 ft. on the dip of the vein. This was no mean performance, considering the limited skill and experience of the men we had to use as miners. Nearly 30,000 tons of ore were taken from this vein. The ore mine contained just enough gold to pay the operating costs.

Three other veins were explored less extensively. One was a straight quartz vein, along which openings were made for more than a mile. Although it was the widest, it was not a mineralized vein, carrying only what we termed token gold, or one-hundredth of an ounce a ton. The other two veins were of the sulfide mineralization type. One gave most encouraging assays wherever exposed and sampled, and it, too, was of greater than average width. They were quite some miles away and would have had to be purchased, or the owners taken into the company.

There was one aspect of the situation that, for a time, I feared would exclude the Matagalpa mine from the continuation program. In all Latin-American countries, the mining laws are based upon what is called the Napoleonic Code. This is to the effect that the individual ownership of land is limited to the surface. A person holding title to real estate does not thereby hold title to any minerals found in the subsoil, except for a few specific ones, such as limestone, gypsum, and building materials. All metallic minerals, petroleums, asphalts, and such, wherever found, are the property of the state. By process of denouncement, any individual may secure a perpetual lease and the right to all, except petroleum and salt. In English, we would express this as staking a claim and paying an annual fee for each mine claim taken up, regardless of the value of mineral found, or whether or not the claim is worked. All the veins of the old La Leonesa company and the Matagalpa company were in terrain whose surface was planted to coffee.

Strangers Under Surveillance

The U. S. Army was doing considerable work in Central America. I was called into Managua and was told that we were to be allowed to continue operations because we might be more useful by so doing. I was forbidden to carry on any dealings or to associate with the coffee planters. I was to exercise all possible vigilance as to who visited them, including Americans, especially those employed at the mine. There were two long shore lines, on



MINING IN COFFEE COUNTRY: All of the veins of the old La Leonesa company and the Matagalpa company were in terrain whose surface was planted with coffee.

*Director, Empresa Zopel, Apartado 552, San Jose, Costa Rica.

either of which agents might be landed. However, it was certain that any such would be spotted and accompanied into the United States. The agents were not so much wanted as were the people with whom they would try to make contact. It was different with any such persons who might try to get out of the country that way, for they might carry not only information about highway and landing field construction going on in Central America, but also of any shipping leaving for the United States. So, the appearance of any strangers, even in Army uniform and traveling in jeeps, was to be reported. One such person was the first actually to spot iron pyrites on the dump. He became greatly excited about "coarse free gold" and admitted being an expert with the divining rod.

Houses for staff employes were built of 1-in. boards and roofed with corrugated galvanized sheet iron, in some cases raised well above the ground. The foundations were filled in so that no animals could find shelter below the floors. The floors were laid in locally burned tiles, with an exceedingly low factor of wear. The joint of roof with sides was not closed at the eaves, as the builder claimed mosquitoes never rose that high above the ground. But plenty of other animals did, especially moths at night when the lights were on, and occasionally a kinkajou or a possum. A skunk made the rounds nightly—they were common at night along the road between Matagalpa and Managua.

The use of beaverboard helped to cool off some of the houses and ameliorated, to some extent, the heat of the sun on the metal roofs. If used to give an indoor finish to the sidings, care must be exercised not to leave a space between the inside and outside walls. On the whole, the houses were not too bad when the uncertainty of occupation was considered.

Sewage was disposed of through Imhoff tanks. We did have baths with hot showers. Someone said that ours were the only houses in Nicaragua with hot water supply, except the American Embassy. Two oil drums were used for heating the water. One was laid on its side, slightly inclined; the other was upright. They were connected by pipes so that the heat of the sun would set up convection currents, and the warmer water would collect in the upper tank. This was helped further by a 1,000-watt calrod in the lower tank.

CLOSE WATCH ON ALL STRANGERS: American military authorities directed me to exercise vigilance in checking on the arrival and the activities of strangers, including Americans, who visited local coffee plantations.

The Kitchen

We did not go in for individual housekeeping. There was a staff kitchen, equipped with a wood-burning range. This was used as little as possible, only when the power plant was closed down, for we had an electric range, various roasters, broilers, hot plates, and pressure cookers. A monitor was built into the roof for the entire length of the room. This was screened and resulted in a fairly cool kitchen. Someday I am going to build a kitchen with all the stoves and heaters at one end, in a sort of separate room, like the one in which we placed the assay furnace. Better still, I'll put them all into a regular chemical laboratory hood with balanced glass windows in steel frames that can be raised and lowered like a window shade. In that way, all the odors and heat from cooking will be insulated from the main room. There is no need for any heat to come in from the hood, and all operations can be watched through the windows, which are raised only when some manipulation calls for access. While we lacked many things, and fell far short of a "white kitchen," we had enough equipment to inculcate in the girls who worked there, the hope that someday they might own or work in a "white kitchen" like the pictures in the "Revistas." Such a kitchen is indeed a far cry from those that prevail in Central America. The only innovation we had in the staff dining room that seems worth mentioning was an arrangement of electric lights to keep saltcellars warm and dry so that the salt would run freely.

Although operating in a coffee country, and on a coffee plantation during the first year, all the coffee beans used were imported from the United States. Later, properly roasted coffee could be bought in Managua. A method of preparing coffee extract was developed, aimed at retaining all the flavor in the beverage and not dispersing it into the air. A cupful of ground coffee was placed in an ice-cube tray, covered with two cups of cold water, and frozen overnight. Next morning, three more cups of water were put into a pot with the frozen block, and heated slowly to the point of boiling. The pot was then placed in the pressure cooker and heated to 15-lb. pressure. After cooling, the pot was removed and the liquor decanted, washing the grounds with two more cups of boiling water. The extract was perfectly clear and completely separated from the grounds. It could be kept in the refrigerator for many days without losing

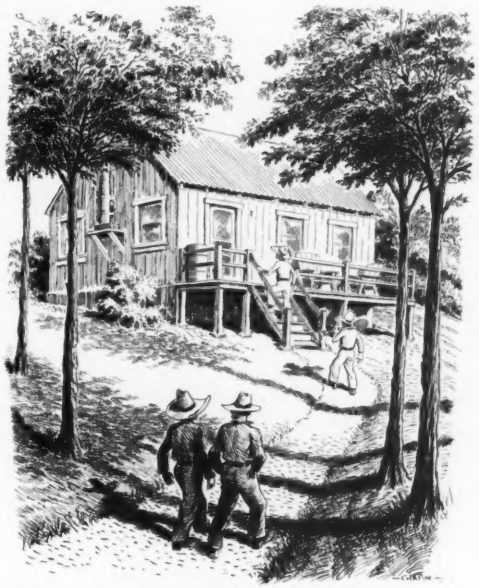
flavor. We heated the coffee almost to boiling temperature for serving, with the addition of more hot water or hot milk. The process completely extracts the coffee, giving a product that is strong enough to flavor ice cream, or for iced coffee. Each pound of coffee thus processed will yield about 125 cups of beverage.

Power

Service included a laundry with electric irons, but a "sun heating" method of soaping. Three electric refrigerators of the sealed-unit type were in use, and ice cubes and flavored ices were made available to everyone. For mine use, a kerosene-burning type of refrigerator generally is the best suited as, in starting up new mines, electric power is not available but kerosene can be obtained. There were many of these in Matagalpa but, from 1942 on, kerosene was one of the scarcest commodities in Nicaragua. From that date on, as long as I remained there, we saw none at the mine. Folks with that type of refrigeration found difficulty in getting a supply of kerosene. I had several of them in Peru. Although the descriptive literature gives one the idea that they operate on a mere pilot flame, the smallest size burns about 20 gals. a month.

At most mines, electric power becomes available, sooner or later. The cost is the same whether the plant is operating at full capacity or a fraction of it. At such time, it is desirable to change over from kerosene, which may be quite expensive by the time it is delivered at some mines. The idea came to me that it would be advantageous to be able to change over to an electric heating device, so that the original kerosene-operated installation could be changed over by a built-in alternate. In so doing, one could change to whichever he had need for. I liked the idea so well that I went to the company's New York office with it. I was told that the kerosene type of refrigerator was distinctly not an electrically operated device, and never would be. My reception was such that I thought it best to get away from there before they might decide to chuck me and my idea right out the closest window, down onto Fifth Avenue.

Motor-driven household equipment has short life under low or varying voltage. In six years at Matagalpa, eight sealed units were bought for the three refrigerators. It seems to me that an electric heater could be so designed with various taps that the taps could be changed to keep the heating right on the dot, as dry weather and low voltage came around annually. In 1947, electric refrigerators began showing up in Costa Rica.



STAFF EMPLOYES' QUARTERS: Houses for staff employes were built of 1-in. boards, with corrugated galvanized sheet iron roofs. In some cases, the houses were raised well above the ground, with the air space filled in.

Another kitchen-and-dining-room unit was operated for the junior staff. A trial was made to open a large general dining room for the entire personnel. In the early days of the Pis-Pis mines, all employes were fed by the company, at a cost of 35 cents a man. The staff generally used an annex dining room in the same building, all being supplied from the same kitchen. The staple food supplies, flour, rice, beans, lard, and sugar, were imported from New Orleans. Beef and pork, usually cornfed for some time before, were slaughtered at the mine. Meat that could not be used at once was preserved in brine. If used soon enough, it was almost indistinguishable from fresh meat; if corned, it provided a change of menu.

At Santa Rita, we had a couple of Chinese and a couple of Jamaicans to look after the planting of whatever we could grow, without the ants destroying it. At one time, these men claimed that 30,000 casava plants and some 35,000 bananas were growing. At Matagalpa, we had one refrigerator that was used solely for meat. The meat was trimmed and cleaned carefully after slaughter, then laid away frozen for two weeks between crushed papaya leaves. Or else it was prepared into one of two Peruvian dishes, namely, escabeche and seviche—pickling with vinegar and bay leaves for the one; with orange or grapefruit juice for the other. There are no "frigerificos" anywhere in Central America, and good meat is unknown except at one restaurant in Managua.

Diet in the Tropics

Contrary to the ideas of many people from the United States, a high protein diet is more necessary in the tropics than elsewhere. As good meat is hard to get, the natural tendency is to turn to a diet high in carbohydrates, resulting in deficiency diseases that often terminate one's stay. No attempt is made at special feeding of animals before slaughtering. For example, the connective tissue in beef muscle is so tough that, when put through a meat grinder, the product is apt to come out chain-connected in one continuous string. Perhaps, only breeding can do much to correct this. Hog meat is soft and flabby. The fat, or lard, is also that way, and of an almost transparent white color, instead of the opaque snow-white to which we are

accustomed. This cannot be corrected by heating to drive off the water, as I thought; that is not the cause. What we consider a normal consistency is only to be attained by corn feeding.

The slaughtering of calves is prohibited, so there is no veal. Sheep are not seen anywhere in Central America. The abundance of ticks probably makes sheep raising impractical, or it could be because no one has ever thought to try it in an intelligent manner. However, there is no reason why goats should not thrive, and young kids make a splendid variation in a diet otherwise limited to beef and pork; they are as tender and edible as young lamb, maybe even more so. Peru is the only country I have lived in where kid was a regular item on the menus. Of course, there is a certain age at which these animals become inedible, except to the most non-epicurean taste.

AT SANTA RITA: We assigned two Chinese and two Jamaicans to take care of planting anything that would grow at Santa Rita.

The Menu at Matagalpa

At Matagalpa, we enjoyed a varied vegetable and fruit menu, as the plantings had been made of excellent varieties of mangoes, oranges, grapefruit, lemons, aguacates, bananas, and maranon nuts, or as you call them, cashews. A large orchard of papayas was planted and soon the trees were large enough to yield fruit. We once counted 72 on one tree, with the largest weighing 14 lbs. These were produced in quantities large enough to supply all the miners, at a charge of a few cents each. The garden produce included spinach, cabbage, Brussels sprouts, carrots, turnips, lettuce, and many kinds of kitchen herbs. We introduced broccoli, never seen in that part of the country; also, Golden Bantam corn that had all the flavor of the home product. But the dogs soon found the corn and ate most of the crop before we had enjoyed more than a few meals, and before we found out what was causing the damage. Seed had to be brought in fresh for each planting, as it completely lost germinating power after a few months' storage. Second-generation seed showed atavism, and produced offspring whose parentage could hardly be suspected.

Plantings were made of eucalyptus, but of 300 seedlings set out, only a few survived longer than three years. The soil mantle was about 6 in. deep, lying upon a somewhat altered porphyritic rock with few fissures or joints. Trees like eucalyptus or papayas that send down a strong tap root could not stand up against the strong winds that prevailed during certain seasons. The papayas were top-heavy with fruit, and the eucalyptus grew rapidly to considerable height, with trunks that one could encircle with the fingers. They developed with a corkscrewlike twist that would have made the timber useless if it had grown to stull size.

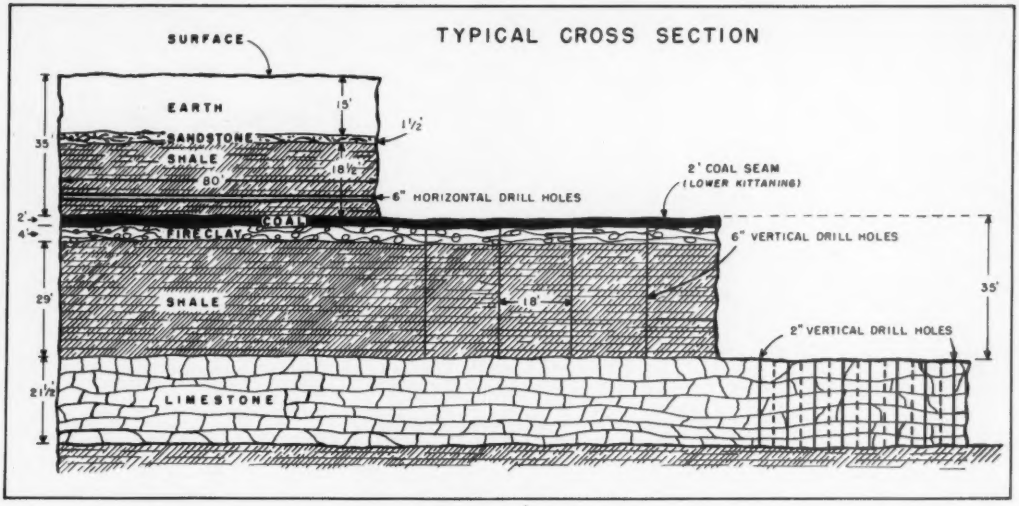
A fiber plant called Roselle was grown in the garden. It produced a maroon fruit that looked more like a blossom. When used for making jelly, it left cranberry jelly hors de contest. Along with wild grapes and blackberries, it could be made into a wine with only one drawback—there never was enough of it.

Housekeeping Chores

Housekeeping chores were in charge of two English women—one following the other. They kept a plentiful stock of preserves on hand, made from local fruits. Young girls about 12 years of age proved best for house servants. Usually, they were brought in by their mothers who had trained them in the work, had taught them to sew by hand and by machine, to cut out patterns, and to make dresses. If they could not read and write, they had to finish their work by two o'clock in the afternoon and attend school.

The girls were provided with shoes, brought in from the United States—the local footwear is more expensive and without wearing qualities. The imported shoes were the big inducement that created a waiting list for the house servant jobs. Besides, they were paid enough to amount to something. One youngster developed into an excellent cook. Her guava jelly was the equal of any produced anywhere, and the bread she made, especially the whole wheat variety, was excellent. But, she could not get the knack of pedaling a sewing machine. When my wife told me about it, I replied, "Tell her to take off her shoes." I got a stony stare for such a suggestion. However, the barefooted girl could feel the rhythm of the machine and soon she had no more trouble on that score. At times, efforts to help them seemed wasted. At the age of 12, the girls could not realize that we were trying to train them so that they could enjoy a better standard of living when they reached adulthood.

(To be continued.)



VARIABLE OVERBURDEN: The drawing above indicates the different kinds of material that make up a 70-ft.-high bank of overburden covering the 22½-ft. stratum of limestone, and the sizes and locations of drill holes employed in blasting the overburden and the limestone.

LIMESTONE

(Continued from page 46)

horizontally into shale, using an auger drill. The drill holes are loaded with 5 by 16-in. cartridges of the equivalent of a 35% ammonia type of dynamite, on a ratio of a pound of explosives to each 7 cu. yds. of overburden. The charges are primed with No. 6 Electric Blasting Caps and blasts are fired with a conventional blasting machine. The blasted material is excavated and cast onto a spoil bank by the employment of two Bucyrus-Monighan draglines—a Model 9W with an 8-cu. yd. bucket and a Model 650B with a 10-cu. yd. bucket. The 650B rig, a recent purchase, is equipped with a 235-ft. boom, the longest in the United States. The addition of the new dragline has greatly accelerated stripping operations.

The recovery of the seam of coal 2-ft. thick is the next step in stripping operations. The coal is excavated and loaded out by means of 1½-cu. yd. Diesel shovels. The recoveries take care of the company's requirements for their locomotives and kilns and, in addition, provide a sizable tonnage for sales in the outside market.

The final stripping operation is the removal of a 4-ft. seam of fire clay and a second seam of shale about 30 ft. thick. This is done by drilling 50 vertical holes 6 in. in diameter, 33 ft. deep, spaced on 18-ft. centers, using a Linden Pitz tractor-mounted shale drill with auger bits. The holes are loaded with 5 by 24-in. cartridges of Hercomite* 4, on an explosives loading ratio of a pound of dynamite to 4 cu. yds. of overburden. The charges are primed with Primacord and blasts are fired with a No. 6 Blasting Cap and safety fuse. The blasted material is excavated and dumped onto a spoil bank by the dragline crews.

WAY BACK WHEN: In 1890, primary blasts in the limestone formation were made with black blasting powder. Such blasts dislodged and moved the stone away from the face with limited breakage. It was later reduced to one-man size by hand labor.

Recovering the Limestone

With the stripping of the overburden completed, the limestone is recovered as follows: A battery of Cleveland D-14 wagon drills is employed to drill approximately 150 vertical holes into the limestone, 2 in. in diameter, 21½ ft. deep, staggered on 7 by 7-ft. centers. This provides a pattern of 15 holes across the width of the working face and 10 rows of holes in depth. Each hole is loaded with 9 cartridges of Gelamite* 1, and 22 cartridges of Hercomite 7A in 2 by 8-in. cartridges, on a loading ratio of 1 lb. of explosives to 3.4 tons of limestone in the

*Reg. U. S. Pat. Off.

solid. The outside holes at both ends of each row are column-loaded; the remaining holes are deck-loaded. The charges are primed alternately with zero and fourth period delay Electric Blasting Caps. Each hole is stemmed to the collar with drill cuttings. Blasts are fired with a 220-volt circuit. Breakage is uniformly excellent. The blasted limestone is excavated and loaded into quarry cars by two 4-cu. yd. Marion electric shovels. Trains of loaded cars are hauled to the plant by a 25-ton Whitcomb Diesel locomotive.

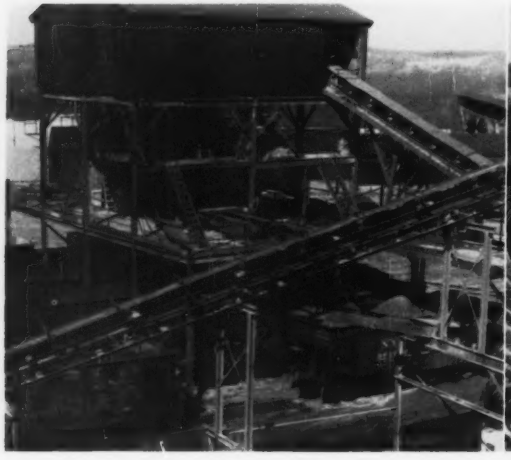
Air for the drills is supplied by three Ingersoll-Rand compressors—two Imperial type 10's, 1,000 c.f.m., and one Class PRE-2, 1,500 c.f.m.

The Carbon Limestone Company's plant in Mahoning Township, Lawrence County, Pennsylvania, processes coal and limestone from its Ohio stripping and quarry operations for extensive distribution of fluxing limestone to the blast furnace trade; coarse concrete aggregate and sand, concrete block, and concrete brick to contractors and builders; plus agricultural and superfine limestone and poultry chips to the farmers.

The management of the company's business is directed and supervised by Frank B. Thacher, president; Philip E. Heim, vice president, sales; George Donaldson, vice president, production; and Urban Masson, superintendent.

COMPANY OFFICIALS: Left to right; Philip E. Heim, vice president, sales; George Donaldson, vice president, production; Frank B. Thacher, president; Urban Masson, superintendent.

CRUSHING PLANT: The locomotive delivers a train of cars filled with blasted limestone from the quarry to the crushing plant for reduction and screening to predetermined sizes.



WASHING PLANT: After the limestone has been crushed and screened, it is moved on conveyors to the plant shown above, where it is washed and loaded into railroad cars for shipment.

BLOCK PLANT: Some of the crushed limestone is processed in the plant visible in the background for use in highway work. Foreground, cars of furnace stone await shipment to the trade.

MT. MORRIS DAM

(Continued from page 41)

ward, using a stoping method, it was carried into each abutment to the limit of the zone of open joints in the rock—about 40 to 120 ft., up to elevation 790 ft. Hercomite* 5 dynamite, in 1¼ by 8-in. cartridges, and Hercules No Vent* All-Metal Delay Electric Blasting Caps, from zero through the 12th delay period, were used in this operation. A grouting and drainage gallery is provided for near the bottom of each wall. This is connected to a vertical access shaft in the back of the curtain wall and to a grouting gallery in the bottom area.

The excavation for the foundation of the dam on the south side was completed in April, 1949. Work on the south side curtain wall stoping operation had progressed sufficiently to start the concrete work on the dam foundation. The first bucket of concrete was poured April 27, 1949.

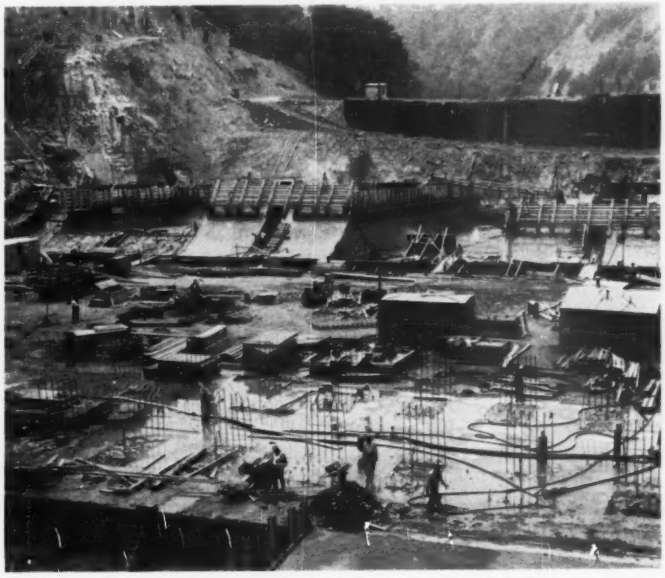
Stone for Aggregate

Crushed stone for concrete aggregate is furnished by General Crushed Stone Company from its North LeRoy, New York, quarry and plant, under the supervision of Merl Price. The stone is delivered to the contractor in crusher-run sizes from 1 in. to 7 in. It is hauled 23 miles by truck to the job site. At the dam site, the stone is further processed and screened to the required sizes of from 6 in. to 1 in. The smaller sizes screened out are made into sand by means of a Jeffrey rod mill. By a system of conveyors leading from the stone-processing plant and the sand-manufacturing plant, the various sizes of materials are stocked in large piles. A 24-in. conveyor belt was installed in a tunnel under these stock piles for delivery of these materials to the hoppers on top of the mixing plant. The mixing plant consists of three 4-cu. yd. Johnson mixers. Ice used in the mixing operation is manufactured on the site and conveyed to the hoppers as needed.

An electric street car chassis carrying two 8-cu. yd. buckets and two 4-cu. yd. buckets moves on tracks, utilizing a third rail for power. It shuttles back and forth beneath the mixer along the

*Reg. U. S. Pat. Off.

FOUNDATION AND KEYWAY AREAS: Rock had to be blasted to make provision for the foundation areas of the dam. The forms in the center are for mass concrete.



STILLING BASIN: Workmen constructing the stilling basin floor 5 ft. thick, 240 ft. long, and 470 ft. wide. Two rows of baffles, an end sill, and concrete training walls will be built later.

CONCRETE MONOLITHS: The center high blocks of concrete above the stream bed are at the finished spillway elevation. The 5 by 7-ft. sluices are visible at the water level.

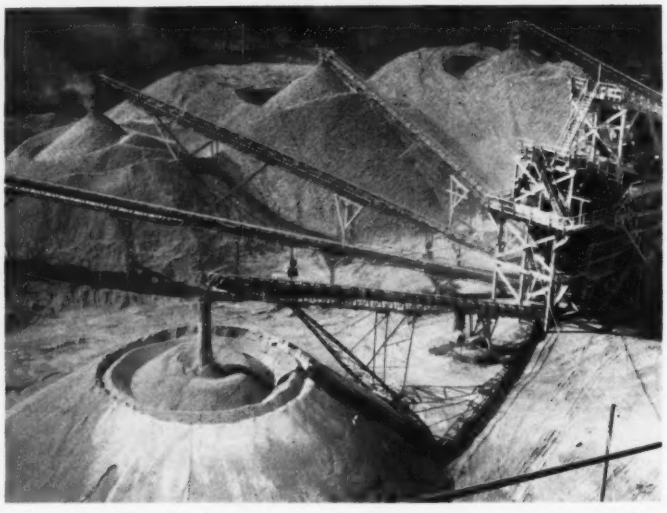
upper wall of the gorge to meet the cableway. At that point, the cableway picks up the buckets and transports them to the forms being poured. With two cableways in operation, an 8-cu. yd. bucket of concrete can be placed every four minutes.

During the year 1949, monoliths No. 5 through No. 10 on the south side, with the exception of No. 7 and No. 9, were raised to the approximate elevation of 625 ft. Monoliths No. 7 and No. 9 were raised only to elevation 575 ft. to provide for the passage of the river through them, and to permit work on the north side to continue.

Floods

During the winter of 1949-50, the cofferdam was swung over to the north side of the river and excavation for the foundation on that side was started. The foundation excavation was practically completed in the early spring months when the Genesee decided to go on another rampage. It raised to such a height that it became necessary to flood the inside of the cofferdam to avoid the possibility of the cells being washed out by the high water.

Concrete work was resumed early in the spring of 1950, and operations progressed at a rapid rate throughout the spring, summer, and fall months. By late October, 1950, monolith No. 10 had been completed in height and No. 6 and No. 8 were nearing completion.



STONE AND SAND: The above plant screened crushed stone supplies and stock-piled them for future use as aggregate material. A mound of manufactured sand is in the foreground.

Mt. Morris Dam is being constructed under the direction of the Department of the Army, Corps of Engineers, Office of the District Engineer, Buffalo District, Buffalo, New York. At the beginning of operations, Colonel H. D. Vogel was district engineer at Buffalo. Upon leaving for other work with the Corps of Engineers, he was succeeded by Colonel F. H. Forney. At present, Colonel E. W. Schull, Jr., is the district engineer. At the job site, J. E. Harnes is resident engineer and is assisted by H. V. Kramer.

The representatives of Mt. Morris Dam Builders who are active in the construction of the dam are J. C. Maguire; C. W. Black, vice president of The Arundel Corporation; S. E. Hunkin, president of The Hunkin-Conkey Construction Company; L. E. Dixon,

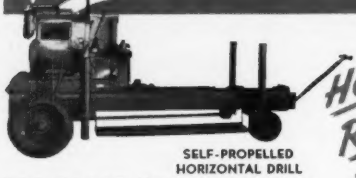
president of L. E. Dixon Company; and Floyd Shofner, a partner in Shofner, Gordon and Hinman. Among the contractor's supervisory personnel are William V. Greeley, project manager; G. E. Bralye, chief engineer; F. S. Bryant, field superintendent; J. L. Wixson, general foreman; B. M. Choate, tunnel foreman; W. J. Hinchy, excavation foreman; L. W. Freckleton, machinery superintendent; G. D. Hill, Sr., aggregate superintendent.

Letchworth Park

Mt. Morris Dam is located just north of one of the most picturesque areas in the eastern part of the United States. Letchworth Park has been developed along both banks of the Genesee River. With its breath-taking gorge scenery and waterfalls, it is known as the Grand Canyon of the East. The reservoir to be formed by the dam will make this area of New York State even more popular. The Genesee State Park Commission, which has jurisdiction over the park, has purchased additional land and plans to acquire additional acreage to develop it further. The park area will ultimately comprise about 14,000 acres. New roads, new picnic areas, and new cabins will be added to supplement the present recreational facilities at Letchworth Park. Here will be found opportunity for recreation in the outdoors at its best, for, side by side, are the "works of man, and the works of God."

THE LEROY QUARRY: The crushed stone required to build Mt. Morris Dam, totaling 1,500,000 tons, is being supplied by General Crushed Stone Company's LeRoy, New York, quarry.

McCarthy Drills PAY OFF!



SELF-PROPELLED HORIZONTAL DRILL

FOR BLAST HOLE DRILLING

● Heavy all welded steel carriage and four individually adjustable leveling jacks make setups faster, drilling smoother. Fingertip hydraulic control permits instantaneous change of drilling feed. Bores 5 to 10-inch diameter blast holes to horizontal depths of 120 ft. or more.

Heavy-Rugged

✓ McCARTHY DRILLS PAY THEIR WAY
✓ MAKE MORE MONEY FOR YOU
✓ RECORDS SHOW 40% MORE HOLES
✓ LIST OF USERS ON REQUEST

● McCarthy Vertical Drills adapt to any job where ordinary rock formations are to be blasted.

Designed with compact retractable hydraulic tower for Truck, "Cat," Half-track or Jumbo mountings. Power shafts made of tough alloy steel. Simplified construction throughout.

Over-all height with tower reclining: 7 ft., 4 in. Wt.: 5,100 lbs. All McCarthy units can be operated with Gasoline, Diesel or Electric power units. Write for descriptive literature.

Powerful

VERTICAL DRILL

FIFTY YEARS DRILLING EXPERIENCE 1901-1951

SALEM THE SALEM TOOL COMPANY SALEM

NEWS NOTES

INGERSOLL-RAND WAGON DRILL

Ingersoll-Rand announces that a new wagon drill, known as the FM-3, is available. The manufacturer claims the new unit is designed to permit unlimited drilling positions of the tower or drill guide. It is recommended for the toughest drilling jobs in road building, construction, quarrying, and foundation work—for any job where a large volume of sustained high-speed drilling is required.

The flexibility of the unit permits easy drilling in any position encountered in modern rock excavation. The yoke can be lowered within the frame, placing the drill in the lowest desired position for toe-hole work. For higher holes a hoisting mechanism, consisting of a powerful worm and pinion gear actuated by a ratchet handle, easily raises the drill in a few moments.

Vertical drilling close to a face is easy because the drill extends out beyond the limits of the carriage when the roller-bearing swivel-mounted wheels are turned 90 degrees.

The unit is equipped with a two-quart capacity lubricator to provide ample lubrication for an entire day's work. It is designed for easy filling and cleaning.

The FM-3 mounts the powerful, heavy-duty Ingersoll-Rand X-71-WD rock drill as its drilling unit. The FM-3 outfit handles 6-ft. steel changes and is good for holes up to 24 ft. deep. Bits up to 4-in. gauge can be used.

For additional information write Ingersoll-Rand Company, Dept. RD, 11 Broadway, New York 4, New York.

GARDNER-DENVER UTILITY DRILL

A new, lightweight utility drill for plant maintenance crews was recently announced by Gardner-Denver Company of Quincy, Illinois. The S17 utility drill comes in a handy carrying case with a complete kit of drill accessories, including a 14-in. drill steel and three assorted-size rock bits, a star drill adapter, and 25 ft. of air hose.

The Gardner-Denver S17 is said to be a full-fledged, self-rotating pneumatic hammer drill that weighs only 19 lbs. According to reports, it's a handy tool for placing anchor bolts, for running conduit, cable, pipe, and for many other jobs. It will drill concrete, brick, or stone with standard drill steel, and a star drill adapter furnished with the drill accommodates standard star drills. A special stop-rotation feature converts the S17 to a lightweight chipping hammer or pick.

Safety for the operator was an important consideration in designing this drill, according to the manufacturer. The hand-formed "D" handle is convenient to hold—while the "safety first" trigger throttle—with partial feed position for easy hole starting—contributes to the operator's safety.

WORTHINGTON AIR COMPRESSOR

A new two-stage, air-cooled, 30-cu. ft. compressor is announced by Worthington Pump and Machinery Corporation, Holyoke, Mass. The compressor has a maximum operating pressure of 150 lbs. It is equipped with an A.S.M.E. air receiver, oil bath air cleaners, and a protective V-belt guard.

Other features include circumferential cooling fins; tube and fin-type air-cooled intercooler; positive by-pass unloader holds inlet valve open during idling period; Worthington "Feather" valve; separate, close-grained, cast-iron honed cylinders; full floating wrist pins; oil dippers for controlled lubrication; aluminum low-pressure piston and cast-iron, high-pressure piston of equal weight for proper balance.

JOY MULTI-PURPOSE HOISTS BULLETIN

A new 16-page bulletin, 76-X, released by Joy Manufacturing Co., Oliver Building, Pittsburgh, Pa., describes the complete line of Joy single-drum, multi-purpose hoists for mines, construction jobs, oil fields, and industrial plants. The bulletin contains complete description and specifications for hoists with capacities from 500 to 3500 lbs., driven by Turbinair, Pistonair, electric, or gasoline engines. A handy SELECT-O-HOIST chart simplifies the choice of any hoist to fill a particular need.

BUCYRUS-ERIE TRANSIT CRANE

Bucyrus-Erie Company, South Milwaukee, Wisconsin, announces production of the new 22-B transit crane. This new wheel-mounted excavator has been engineered similar to its counterpart, the crawler-mounted 22-B.

A new crane-type boom for crane, clamshell and dragline operation has been designed to combine strength and length. Inserts may be used to increase the 30-ft. boom to 80 ft. Long booms are quickly folded. Both hoist line and boom lowering are power-controlled to insure safety. Boom stops prevent raising beyond safe limits.

It may be converted in the field for shovel, dragline, dragshovel, clamshell, or crane operation. In excavator service, the buckets and dippers are ¾-cu. yd. capacity.

P&H TRENCH HOE

Announcement is made by Harnischfeger Corporation, Milwaukee, Wisconsin, that its ½-yd. capacity Model 150 trench hoe is now equipped with the new "Gooseneck Boom." The new boom follows the design which was introduced recently on the P&H Model 255-A.

The design of the "Gooseneck Boom" makes possible higher speeds, greater digging depths, maximum ruggedness, and better overall performance. In addition, this machine is adaptable for use as shovel, dragline, clamshell, or crane.

Fifty per cent greater speed is obtained by this trench hoe through the use of a two-part hoist line. Its greater digging reach and depth, and greater dumping height, mean fewer moves and more yardage.

More power is made available for the toughest digging by a low gear transmission. This trench hoe can start a trench with a vertical cut and can trim vertical walls. A special hoe stick linkage provides a chopping action.

Complete information on the P&H Model 150 trench hoe may be obtained by writing to Harnischfeger Corporation, Small Excavator Division, Milwaukee 14, Wisconsin.

NORDBERG MACHINERY

All types of machinery manufactured by the company are contained in a new 28-page two-color bulletin published by Nordberg Manufacturing Company, Milwaukee 7, Wisconsin.

Fully illustrated with installation and product photographs, Bulletin 187 also gives design data on Nordberg two- and four-cycle stationary and marine Diesel engines, gasoline marine engines, Symons cone crushers and screens, mine hoists, machinery for the basic processing of ores and minerals, air and gas compressors and railway track maintenance equipment. Various industrial applications of this machinery are also contained in this bulletin. Bulletin 187 is available free upon request.

CRAWLER DIESEL TRACTORS

John M. H. Shline Company, 342 Madison Avenue, New York 17, New York, has been appointed the exclusive representative and distributor in the United States for crawler Diesel tractors and equipment manufactured in England by the internationally known firms of John Fowler & Co. (Leeds) Ltd., established in 1850, and Marshall Sons & Co. Ltd., established in 1848. Further information about these crawler Diesel tractors, ranging from 20 hp. to 95 hp., will be supplied upon written communication to John M. H. Shline Company.

EUCLID DIESEL-POWERED EQUIPMENT

The Euclid Road Machinery Company, Cleveland 17, Ohio, has published two new 16-page booklets covering Cummins- and General Motors-powered Euclid equipment. These list by model number the various Diesel engines and the Euclid equipment in which they are available. Specifications for Euclid rear-dump and bottom-dump hauling units, scrapers, and loaders are included, as are lists of engine dealers and Euclid distributors in the United States and Canada.

Copies of Form EGM-1 covering General Motors and ECE-10 on Cummins-powered Euclids are available from dealers, main offices of the engine manufacturers, and from the Euclid Company.

CONVERTIBLE DIESEL ENGINES

Detroit Diesel Engine Division, General Motors Corporation, 13400 W. Outer Drive, Detroit 28, recently announced the introduction of a new option on Series 71 Diesel engines that enables them to burn natural gas in accordance with Diesel high-compression principles. Option is available both on new engines and engines already in use. Change-over permits engines to burn either natural gas with pilot charge of Diesel fuel or Diesel fuel alone. Change from dual-fuel to Diesel-fuel operation is accomplished by moving small lever on gas governor assembly. Dual-fuel unit has no electrical ignition system. Natural gas is delivered to cylinder and fired by small charge of Diesel fuel at top of compression stroke. Engine instantly adjusts itself between use of natural gas and straight Diesel fuel in case gas pressure falls off. Automatic shut-off valve activated by rise and fall of engine oil pressure cuts off flow of gas when engine is not in use.

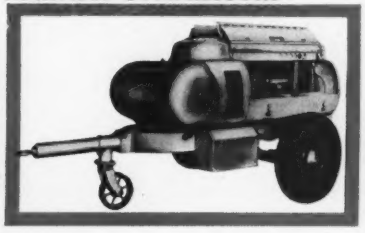
Use JOY AIR-POWER and TOOLS

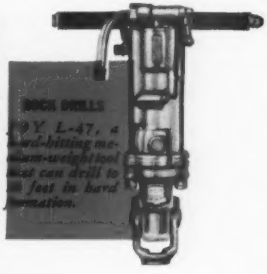
for all-around best performance

ON THE JOB

JOY Portable Compressors and "Silver Streak" Air Tools make a highly efficient, time-and-money-saving team—the most modern units you can put on the job. They're light, compact and easy to handle, yet ruggedly built for real heavy-duty service. JOY Portables are available in seven sizes, ranging in capacity from 60 to 630 CFM at standard pressure. JOY Air Tools feature the exclusive "Dual Valve" that makes air do more work, plus cadmium plating for better lubrication, closer tolerances, and prevention of rust and scoring. • Let us show you how JOY equipment can reduce your costs, and produce more work per man-hour. *Write for bulletins, and ask for an actual demonstration.*

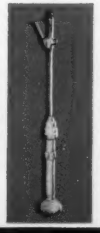
PORTABLE COMPRESSORS





SHEETING DRIVERS

JOY Q-81, an adaptation of the K-81 for driving wood or light steel sheeting.



BACKFILL TAMPERS

JOY C-35, an easy tool to handle, yet delivers powerful blows for faster tamping.

SPADERS

JOY M-2, a light tool for digging in clay, shale, hardpan, or hard-frozen ground.

Consult a Joy Engineer

W&D C2060

JOY MANUFACTURING COMPANY

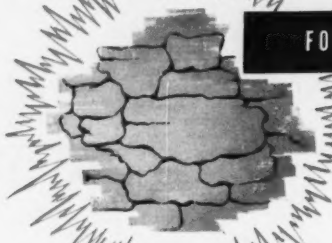
GENERAL OFFICES: HENRY W. OLIVER BUILDING • PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

Permissibles

THAT GIVE THE MOST FOR YOUR DYNAMITE DOLLAR

One of the permissibles on the Hercules list will shoot your coal the way you want it, and make every dollar you spend for explosives go further. Let Hercules help you to select the permissibles best suited to *your* coal and working conditions.



FOR ROCK WORK

COLLIER® C
RED H® B
HERCOGEL® A
HERCOGEL 2

FOR WET WORK

HERCOGEL A
HERCOGEL 2

FOR COARSE COAL

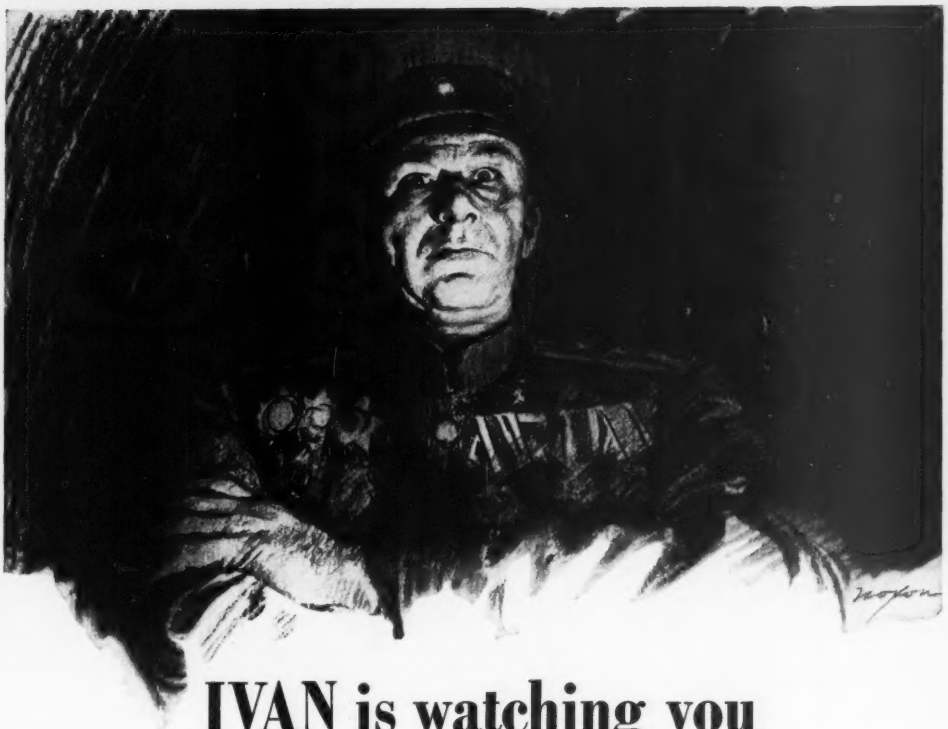
RED H C
RED H D
RED H F
BITUMINITE® D
RED H A
RED H L

FOR FINE COAL

COLLIER C
RED H B

HERCULES POWDER COMPANY 990 King Street, Wilmington, Delaware

XR50-9



IVAN is watching you

IVAN is a dyed-in-the-wool Communist. There are only 6 million party members like him in all Russia, yet these Communist brass-hats enforce the iron dictatorship of the Kremlin over *200 million* Russians.

He's sold to the hilt on Red ideas. Which means he's out to get *you*. He believes it's either you or him . . . that the world is too small for both.

Ivan is working hard to beat you down. He has a big head start.

Right now he's got you in a bad spot.

Ivan is afraid of only one thing.

He fears your ability to out-produce him in guns, tanks, planes.

Frankly, he doesn't think you value your free system enough to do it . . . to make willingly the sacrifices he has squeezed out of the Russians.

But he's wrong!

Because you and all of us have set out to build more and better weapons—to do it faster all the time.

We must use every bit of know-how and inventive skill we have to improve our machines and methods—to turn out more and more for every hour we work. Only in this way can we become militarily strong.

But we've got to supply essential civilian needs as well. We can't allow needless shortages to take prices skyrocketing and lower the value of our dollar.

Sure, that means sacrifices for everybody. But doing this double job well is the only sure way to stop Ivan in his tracks—and to save the freedoms which are ours and which he has never known.

FREE *. . . this important booklet tells you how our American System Grew Great*

How Americans developed better machines, power and skills to build a great nation . . . Why we have been able to produce constantly more per hour . . . How this has given us the world's highest living standard.

How we can meet today's challenge—Why we must expand our productive capacity . . . supply arms and essential civilian needs, too. Read how this dynamic process works in free booklet, "The Miracle of America," endorsed by representatives of management and labor. Send for your free copy today!

MAIL THE COUPON—
The Advertising Council, Inc., 25 West 45th St., Dept. B. P. New York 19, N. Y.

Name_____

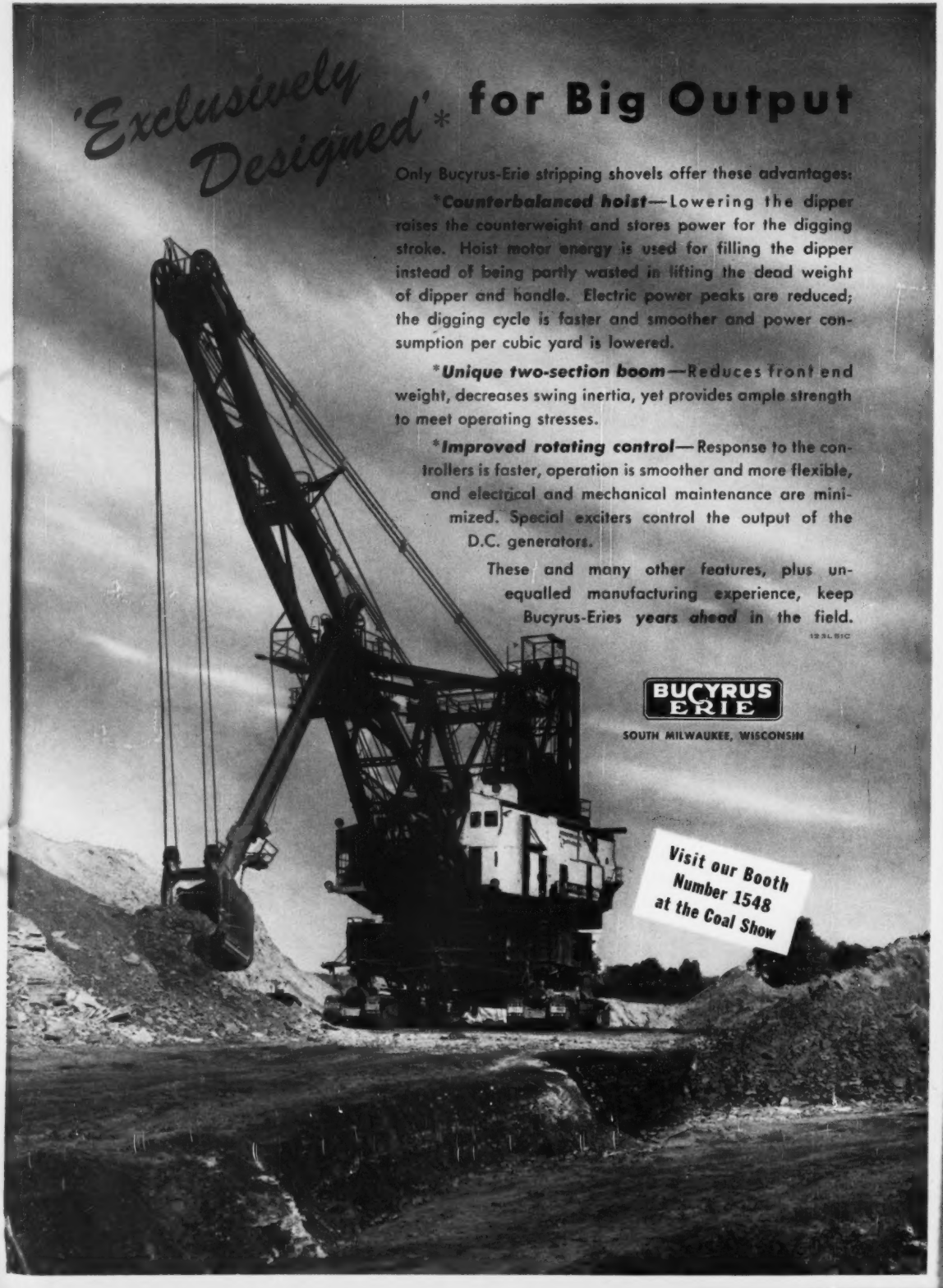
Address_____

Occupation_____

This advertisement, approved by representatives of management, labor and the public, is published in the national interest

By **THE EXPLOSIVES ENGINEER**

THE BETTER WE PRODUCE
THE STRONGER WE GROW


'Exclusively Designed'* for Big Output
Only Bucyrus-Erie stripping shovels offer these advantages:
*Counterbalanced hoist—Lowering the dipper raises the counterweight and stores power for the digging stroke. Hoist motor energy is used for filling the dipper instead of being partly wasted in lifting the dead weight of dipper and handle. Electric power peaks are reduced; the digging cycle is faster and smoother and power consumption per cubic yard is lowered.
*Unique two-section boom—Reduces front end weight, decreases swing inertia, yet provides ample strength to meet operating stresses.
*Improved rotating control—Response to the controllers is faster, operation is smoother and more flexible, and electrical and mechanical maintenance are minimized. Special exciters control the output of the D.C. generators.
These and many other features, plus unequalled manufacturing experience, keep Bucyrus-Eries years ahead in the field.
123L51C
BUCYRUS ERIE
SOUTH MILWAUKEE, WISCONSIN
Visit our Booth Number 1548 at the Coal Show

Progress Reports Reveal Faster Progress

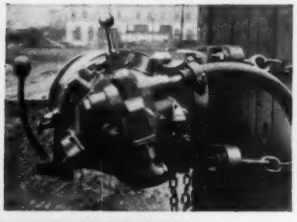
when *Gardner-Denver's* in your picture!

Air pressure's always up —when Gardner-Denver Portables feed your lines. Cylinders are water-cooled *all* the way down for all weather efficiency—compressors are two-stage for any altitude performance.

Holes are spotted quickly—drilled fast and clean with Gardner-Denver Wagon Drills.

Demolition proceeds at a steady pace—Gardner-Denver Breakers are easy on the operator—tough on concrete.

A clean hole drills faster — and Gardner-Denver Sinkers are noted for hole cleaning ability, powerful rotation.

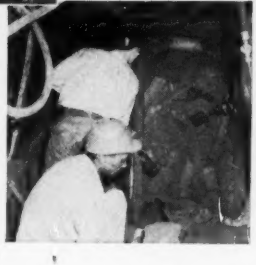


For speedy pull and haul—powerful Gardner-Denver Air Hoists are easy to control.

Saves shop time for all pneumatic tools—L012 Automatic Oiler shuts off air when it runs out of oil.

Keeps water out of your way—Top-Suction VP4 Sump Pump won't burrow in the mud—keeps grit out of the pump shaft seal.

Write for further information.



Packs backfill swiftly and firmly—Gardner-Denver Tampers are easy to hold—seldom require maintenance—non-freezing.

Clay or hardpan doesn't waste time—when tackled with Gardner-Denver Clay Spaders and Trench Diggers.

SINCE 1859

GARDNER-DENVER

THE QUALITY LEADER IN PUMPS, COMPRESSORS AND ROCK DRILLS

Gardner-Denver Company, Quincy, Illinois

In Canada:

Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

Special Explosives for Geophysical Exploration

For seismic exploration on land or under water, Hercules has developed a full series of special explosives to give accurate recordings under the varying conditions encountered by field crews. These explosives are quickly available throughout the oil-producing areas. Write for name of nearest distributor.

VIBROGELS®
. . . these special gelatins are designed to give accurate records and uniform results under severe conditions.

GELAMITE® S
. . . economically replaces "Vibrogels" for some seismic work.

SPIRALOK®
. . . time-saving rigid cartridge assembly.

VIBROCAPS®
. . . no-lag seismic detonators.

TITAN® CAPS 10V and 20V
. . . for use where extra-strong detonators are needed.

HERCULES POWDER COMPANY
INCORPORATED
990 King Street, Wilmington, Delaware

X051-1